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ANNUAL REPORT

OF THE

MAINE STATE COLLEGE

AGRICULTURAL EXPERIMENT STATION

1891.

BANGOR:
CHAS. H. GLASS & CO., PRINTERS,
1892.

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Correction.—In Part II, p. 60 of this year's report (1891), remarks are made concerning the supposed peculiar stimulating property of oats, due to a supposed compound avenin. The discussion is based on the assumption that the proteid avenin is the stimulant. Dr. Armsby has kindly called my attention to a fact which I had overlooked, that in 1883 Sanson claimed to have discovered in oats a characteristic alkaloid (see Compt'es rendus, 1883, p. 75 77, and Bied. Centralblatt, 1884, p. 20-21), having a stimulating effect upon the motor nerves of the horse. The alkaloid is undoubtedly the compound to which reference has been made in public discussion, rather than the proteid.

It seems, however, that in 1889, Dr. Wrampelmeyer (see Landw. Versuchs—Stationen 36, p. 299) sought to verify Sanson's conclusions, and after elaborate tests was unable to do so, failing to find any characteristic alkaloid. It appears, then, that there is the same lack of experimental evidence as to the existence and effects of the *alkaloid* avenin as is the case with the *proteid*, and consequently the remarks referred to above on the reliability of certain existing notions, though made under a misapprehension, are applicable to the real facts. W. H. J.

Errata.—On page 186, in table, the third column of figures should be headed, "Nitrogen undigested by pepsin," and the fourth column, "Per cent. total nitrogen digested."

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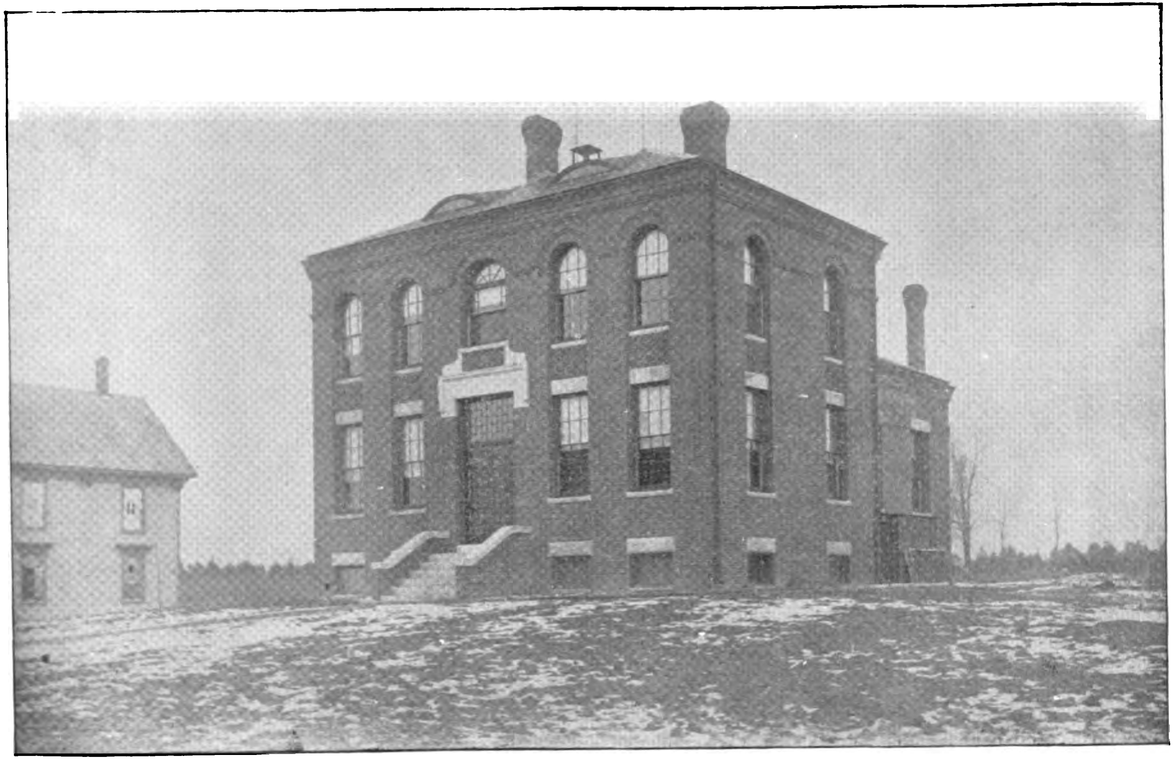

MAINE EXPERIMENT STATION CHEMICAL LABORATORY AND OFFICES.

MAINE STATE COLLEGE,

AGRICULTURAL EXPERIMENT STATION.

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Mrs. J. Hamlin Waitt,	Stenographer and Clerk.

TREASURER'S REPORT.

THE MAINE AGRICULTURAL EXPERIMENT STATION,
In account with
THE UNITED STATES APPROPRIATION.

RECEIPTS.

From the Treasurer of the United States, as per appropriation for the year ending June 30, 1891	$14,999 87

EXPENDITURES.

Construction and repairs	$77 57
Fuel	170 38
Field and feeding	1,625 75
General expense	149 29
Salaries	9,051 49
Horticultural Department	453 14
Library	93 33
Printing	1,831 39
Stationery and Postage	97 03
Travelling expenses	182 76
Veterinary Science	49 71
Water supply	1,300 00
Chemical Laboratory	440 39
Botany and Entomology	26 95
Fertilizer inspection	190 34
Meteorology	24 35
Trustee expenses	48 50
	$15,812 37

DIRECTORS' REPORT.

M. C. Fernald, Ph.D., President Maine State College:

SIR:—The report of the Maine Experiment Station for 1891, which is herewith submitted, contains, it is believed, evidence that the work of the Station is increasing, not only in amount, but importance. During no year of the Station's existence has so large a percentage of its funds been applied directly to actual experimental work, as in the year which now ends. Previously it has been necessary to use quite a percentage of the funds in procuring the required equipments for the various departments, but now that the needed appliances are fairly well supplied, it is reasonable to expect more extensive and more varied experimentation than has heretofore been possible.

LIMITATIONS OF THE STATION RESOURCES.

It is probable that only those who are directly concerned in the management of the Station realize the extent of the demands made upon it for work along the various agricultural lines. We have in the State of Maine stockmen, dairymen and fruit growers, and to each of these classes of producers are presented many problems of great economic importance. More and more are agriculturists looking to the work of the experiment station as a means of solving these problems and the dairyman is not less backward than the fruit grower in asking that he receive his fair share of attention.

In view of the requirements that are laid upon the Station, $15,000 is not a large sum of money, although to some it may seem to be.

It should be remembered, however, by those who have a feeling of disappointment in what is being accomplished, if there are such, that each line of work requires a specialist with special apparatus. It should also be remembered that the scientific problems pertaining to agriculture can not be solved at a uniform rate of so many per day or year as we would manufacture boots or chairs or any other commodity. If through accident, unforeseen circumstances or an error of judgment in the regulation of conditions, an investigation becomes a failure in the season of 1891, it must wait for a repetition until 1892, with no guarantee of success then. There is nothing mechanical about the work of the investigator. He must wait for the place and the hour when he can with certainty declare a new truth or point out a new application of an old truth.

THE FERTILIZER CONTROL.

As has already been pointed out, the inspection of fertilizers is at the present time made possible through the use of money appropriated by the United States Government. In no other state is this the case. It is certainly unfortunate that in Maine we are following a policy which appears to be condemned every where else, for in all other states where a fertilizer control system exists, it is supported by funds obtained either from licenses on the sale of fertilizers, or from direct appropriations by the state. At a meeting of the Association of Land Grant Colleges and Experiment Stations held at Champaign, Ill., the peculiar relation which the Maine Experiment Station sustains in this particular was sharply pointed out. It is certainly very undesirable that our Station should attain notoriety of this kind. In view of the fact that the course pursued at this Station is in this respect not in accord with usage elsewhere, and because there is so pressing a demand for the use of more funds in the actual work of experiment and investigation, I feel compelled to recommend that some means be devised for carrying on the fertilizer inspection without drawing upon the Government Appropriation.

It may be proper to notice briefly in this connection a complaint which is made yearly, and which may now be regarded as chronic, in regard to the publication of the Station analyses of fertilizers. It is claimed by those who find fault, that the results of the inspection should be made known before the time when farmers find it necessary to purchase fertilizers in the spring. To say that this can not be done is a statement of fact, and though the briefest, it may not be a convincing argument with which to meet the complaint. If, however, the farmers of the state could understand the matter as fully as do the officers of the Station, no argument would be required to assure them of the impossibility of going into the markets and collecting two hundred or more samples of fertilizers, representing seventy-five brands, analyzing these samples, making up the report and publishing it before the month of May opens. The fact that the older fertilizer control stations, such as those in Connecticut, Massachusetts and New

Jersey, do not publish the results of their inspection until as late as July, August and September, or at least did not in the year 1891, should convince any who may be dissatisfied that the Maine Station is not derelict in duty. It certainly would be of advantage if the results of the inspection could be known earlier, and there would be general approval of any change in the existing law which would render this possible. None should feel, however, that under present conditions nothing of value is accomplished. If an inferior fertilizer is sold in the state, the Station inspection is sure to discover it, as has been done in several instances, and the publication of the analyses, even several months later than seems desirable, will certainly effectively discourage the further sale of unsatisfactory goods.

Increased Facilities.

Each year since the Station was organized has seen some enlargement of equipment, either of men or apparatus, and the year 1891 has proved to be no exception in this respect. The most notable gain has been in the organization of horticultural work. This was made possible through the election early in the year, of W. M. Munson, B. S., a graduate of the Michigan Agricultural College, and for two years first assistant of Prof. Bailey in the Cornell University Experiment Station. Prof. Munson comes to the Station with a thorough training, both in the scientific relations and in the art of horticulture, and the development which his department has already attained gives excellent promise of future success. During the year a new Head-house has been built in connection with the Forcing-house, partly at the expense of the Station, the interior of the Forcing-house has been improved for experimental purposes, the experimental value of the Station gardens has been greatly increased by the addition of new varieties and by an improvement in arrangement, and the outside work in farmers' orchards in studying varieties and in testing the efficacy of certain fungicides and insecticides has been enlarged. There has also become available through the erection of the new Dairy-house, increased opportunities for the testing of methods in the manipulation of milk, and to some extent this work has been entered upon. In the basement of the new barn, pens especially adapted to experimental swine feeding have been built. On the whole, the past year has been one of substantial progress and it is hoped that what has been done may stand as evidence that the funds of the Station are being carefully applied to the work that is demanded.

A mistake which the management of an experiment station may easily make is to undertake too much, that is, enter upon too many lines of experiment and investigation. A correct conclusion in regard to a principle or fact relating to the practice of Agriculture may be of incalculable value, while an incorrect statement may do great harm. Nothing should be undertaken which can not be thoroughly done, and all experiments and investigation should be sufficiently exhaustive to make possible sound conclusions. For these reasons, there is no doubt but the Maine Experiment Station has multiplied its lines of work up to the limit that is consistent with a wise policy. It is not impossible that in the future restriction, rather than enlargement, may be found necesssary.

ACKNOWLEDGMENTS.

I desire to express my lively appreciation, which I am sure is in harmony with the sentiments of my associates, of the generous and valuable assistance which the Station receives from the representatives in the Station Council of the Agricultural organizations of the State. It is also a pleasure to state that the members of the Station force have labored together during the past year with the utmost harmony; and that those associated with me have taken up the duties assigned them with faithfulness and efficiency.

The Station is under great obligations to J. M. Sears, Esq., of Boston, Mass., for the gift of a fine pair of Tamworth pigs. These animals are now being used for experimental purposes, with results that are already interesting.

Gifts of shrubs, vegetable and flower seeds, etc., have been received as follows:

J. M. Thorburn & Co., New York, N. Y., vegetable seeds.

John Lewis Childs, Floral Park, N. Y., Ipomea Learii, Ipomea Noctophyton, Ipomea Mexicana, seeds of vegetables and flowers.

O. M. Lord, Minnesota City, Minn., Cions Native Plums.

E. W. Burbank, Fryeburg, Me., miscellaneous collection vegetable seeds.

Francis Brill, Hempstead, N. Y., miscellaneous collection vegetable seeds.

H. A. Marsh, Fidalgo, Wash., miscellaneous collection vegetable seeds.

S. L. Goodale, Saco, Me., 10 varieties ornamental trees and shrubs.

The following newspapers and other publications are kindly donated to the Station by the publishers:

Dairy World, Chicago, Ill.
Farmers' Home, Dayton, Ohio.
Holstein Friesian Register, Boston, Mass.
American Creamery, Chicago, Ill.
Farm and Home, Springfield, Ill.
Good Will Record, East Fairfield, Me.
New Dairy, New York, N. Y.
Jersey Bulletin, Indianapolis, Ind.
Monthly Bulletin, Philadelphia, Pa.
Orange Judd Farmer, Chicago, Ill.
Farmers' Advocate, London, Ont.
Maine Farmer, Augusta, Me.
Southern Cultivator, Atlanta, Ga.
American Dairyman, New York, N. Y.
American Analyst, New York, N. Y.
American Rural Home, Rochester, N. Y.
Western Garden, Des Moines, Iowa.
Western Resources, Lincoln, Neb.
Columbus Record, Columbus, Ohio.
Metropolitan Rural Home, New York, N. Y.
The Pharmaceutical Era, Detroit, Mich.
The Sun, Baltimore, Md.
National Provisioner, New York, N. Y.
Massachusetts Ploughman, Boston, Mass.
Practical Farmer, Philadelphia, Pa.
Home and Farm, Louisville, Ky.
New England Farmer, Boston, Mass.
Progressive Thinker, Chicago, Ill.
Louisville Planter, New Orleans, La.
American Homestead, Omaha, Neb.
Mirror and Farmer, Manchester, N. H.
Texas Farmer, Dallas, Texas.
The Husbandman, Binghamton, N. Y.
Hoard's Dairyman, Ft. Atkinson, Wis.
Iowa Farmer and Breeder, Cedar Rapids, Iowa.
Detroit Free Press, Detroit, Mich.
Orange County Farmer, Port Jervis, N. Y.

Farm Journal, Philadelphia, Pa.
Delaware Farm and Home, Wilmington, Del.
The Western Rural, Chicago, Ill.
American Cultivator, Boston, Mass.
Farmer's Review, Chicago, Ill.

W. H. JORDAN,
Director.

MAINE STATE COLLEGE,
ORONO, ME., Dec. 31, 1891.

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INSPECTION OF FERTILIZERS.

The inspection of fertilizers by the Maine Experiment Station for the year 1891 has required the analysis of sixty-four brands of mixed fertilizers and two brands of bone, involving the selection of one hundred and thirty-five samples. The number of brands inspected in 1890 was sixty-four. In order to secure these samples, it has been necessary to send an agent into nearly every section of the State, and during the present season he has occupied the equivalent of the entire time of a month in constant travel. Samples were taken in thirty-two cities and townships, often at several points in the same township. An effort is made to begin this work in March, but it is usually found that new goods have been shipped to but few places so that a successful canvass of the State can not be carried on until April, therefore the completion of the sampling and analytical work can not be reached until late in June. It will be noticed that three samples of each brand have not been secured in all cases.

In general this has been owing to the following causes: Selling of the fertilizer at but very few points, and finding only the goods held over from last year's sales in the hands of nearly all the agents visited.

SELECTION OF SAMPLES.

Samples for 1891 were selected by Mr. W. J. Holden, an agent of the Station, acting under its instructions. The samples were drawn from three or four packages, mostly one hundred pound bags, so that in all cases where three samples were taken the analysis represents from nine to twelve packages of the goods.

The drawing of the samples is accomplished by means of a sampling tube which can be made to reach every portion of the package, and as several drafts are made from each package, it is readily seen that the method of taking samples is a very thorough one, and there is no good reason for supposing that the contents of the glass jar that is forwarded to the Station does not fairly represent the goods sampled. In every instance a sample exactly similar in composition to the one taken to the station is left in the hands of the agent selling the goods, thus giving the manufacturers an opportunity, by procuring an analysis of this sample, to check the analytical work of the Station.

THE TRADE VALUES OF FERTILIZERS FOR 1890.

The trade values given below which are used by this Station are those "agreed upon by the experiment stations of Massachusetts, New Jersey, and Connecticut for use in their respective states during 1891. The valuations obtained by use of the following figures will be found to agree fairly with the *average retail price* at the large markets of standard raw materials such as:"

Sulphate of Ammonia,
Nitrate of Soda,
Dried Blood,
Muriate of Potash,
Sulphate of Potash.
Azotin,
Ammonite,
Dry Ground Fish,
Bone or Tankage,
Ground So. Carolina Rock,
Plain Superphosphates.

	Cts. per lb.
Nitrogen in ammonia salts	18½
nitrates	14½
Organic nitrogen in dry and fine ground fish, meat and blood	15½
in cotton seed meal and castor pomace	15
in fine bone and tankage	15
in fine medium bone and tankage	12
in medium bone and tankage	9½
in coarser bone and tankage	7½
in hair, horn shavings and coarse fish scrap	7
Phosphoric acid, soluble in water	8
" in ammonium citrate	7½
in dry ground fish, fine bone and tankage	7
in fine-medium bone and tankage	5½
in medium bone and tankage	4½
in coarser bone and tankage	3
Potash as high-grade Sulphate and in forms free from Muriate (or Chlorides)	5½
as muriate	4½

"These trade values are the average prices at which in the six months preceeding March the respective ingredients could be bought at retail for cash in our large markets, Boston, New York and Philadelphia, in the raw materials which are the regular source of supply. They also correspond to the average wholesale prices for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations."

The sale of "standard raw materials" in Maine is too small to allow an estimation of values upon the basis of local market prices, so the figures as agreed upon in other New England States, where the subject is very ably and thoroughly studied, are taken for use by this Station,

THE VALUATION OF SUPERPHOSPHATES AND MIXED GOODS.

These trade values are applied to the valuation of Superphosphates and all mixed goods, as follows:

It is assumed that the organic nitrogen of these goods has for its source such materials as dried blood, ground fish, or nitrogenous substances of equally good quality, unless a special examination of some particular brand shows that inferior material like leather has been used. Organic nitrogen in mixed goods is therefore valued at fifteen and one-half cents per pound. As nitrogen in nitrates is rated for 1891 at only a cent less per pound than organic nitrogen, and as with but few exceptions the nitrates are present in very small quantities, no difference has been made in computing the "estimated value" between organic and nitric nitrogen, but both have valued at fifteen and one-half cents. The small increase in the "estimated value" thus caused, while slightly favorable to certain manufacturers, can certainly do the consumer no serious harm. The nitrogen present in ammonia salts is reckoned at eighteen and one-half cents.

The insoluble phosphoric acid of mixed fertilizers is reckoned at two cents per pound, coming as it does largely from mineral phosphates, and in any case being much the least valuable portion of the original material.

The potash is valued at the price of that ingredient in the muriate, unless the chlorine present in the fertilizer is not sufficient to combine with it, in which case the excess of potash is reckoned at the price of the sulphate.

The valuation of a fertilizer is obtained by multiplying the percentages of the several ingredients by twenty (which gives the pounds per ton), and these products by the prices per pound, and the sum of the several final products is the market value of the fertilizing ingredients in one ton. For instance the "station valuation" of a certain fertilizer was obtained as follows:

2.34 per cent.	Nitrogen	equal	46.8 lbs.	per ton	@ 15½cts.......	$7.25
5.05 "	Sol. phos. acid	"	101.0 lbs.	" "	@ 8 cts.......	8.08
1.48 "	Rev. " "	"	29.6 "	" "	@ 7½cts.......	2.22
1.96 "	Insol. " "	"	39.2 "	" "	@ 3 cts.......	1.18
5.12 "	Potash	"	102.4 "	" "	@ 4½cts.......	4.61
Valuation........						$23.34

CHANGE IN METHOD.

In past years separate analyses have been made of the three samples representing the same fertilizer. This year and last, equal quantities of the three samples have been mixed, and an analysis of this mixture has been assumed to give the same result as would be reached by averaging the analyses of the three samples, a method which is undoubtedly correct.

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
784	Allen Fertilizer	American Mf'g Co., Boston, Mass.,	Saco	784
738	Allen Corn Fertilizer	" " " "	Caribou	738
787	Allen Fertilizer for Lawn	" " " "	Saco	787
737 786	Allen Potato Fertilizer	" " " "	Caribou Saco	737 786
782 796 806	Americus Ammoniated Bone Superphosphate	Williams & Clark Co., New York, N. Y.	Kennebunk Portland Oxford	782 796 806
770 789	Bay State Superphosphate	J. A. Tucker & Co., Boston, Mass.,	Dexter Knightsville	770 789
781 776 778	B. D. Sea Fowl Guano	Bradley Fertilizer Co., Boston, Mass.,	Presque Isle Gorham Alfred	781 776 778
811	Bowker's Ammoniated Bone Phosphate	Bowker Fertilizer Co., Boston, Mass.,	Bridgton	811
720 761 766	" Hill and Drill Phosphate	" " " "	Bowdoinham Foxcroft Dexter	720 761 766
817	" Potato Phosphate	" " " "	Richmond	817
721	" Sq. Brand, Bone and Potash	" " " "	Bowdoinham	721
760	" Sure Crop Bone Phosphate	" " " "	Foxcroft	760

RESULTS OF ANALYSES.

Station Number.	Brand.	% Moisture	% Nitrogen	Phosphoric Acid. % Soluble	% Reverted	% Insoluble	% Total	% Available	% Potash	Station Valuation. $ Value of nitrogen	$ Value of phosphoric acid	$ Value of potash	$ Total valuation
734	Allen Fertilizer	13.65	2.36	4.96	1.68	2.10	8.74	6.64	4.59	7.79	11.30	4.13	23.22
738	Allen Corn Fertilizer	15.71	2.39	4.86	1.96	1.82	8.64	6.82	4.91	8.00	11.44	4.42	23.86
787	Allen Fertilizer for Lawns	17.92	2.59	4.20	1.56	2.67	8.43	5.76	4.14	8.57	10.13	3.73	22.43
737	Allen Potato Fertilizer	16.08	2.46	4.34	1.65	2.16	8.15	5.99	4.78	8.12	10.27	4.26	22.65
782	Americus Amm. Bone Superphosphate	12.59	2.56	6.95	2.82	2.28	12.05	9.77	2.24	7.94	16.26	2.02	26.22
770	Bay State Superphosphate	14.14	2.59	1.94	5.57	3.66	11.17	7.51	2.96	8.03	12.91	2.66	23.60
731	B. D. Sea Fowl Guano	13.26	2.45	6.49	2.38	1.93	10.80	8.87	3.05	7.59	14.72	2.74	25.05
811	Bowker's Amm. Bone Phosphate	10.30	2.57	6.86	2.21	2.09	11.16	9.07	2.00	7.97	15.13	1.80	24.90
720	" Hill and Drill Phosphate	10.88	2.65	6.87	2.53	3.19	12.59	9.40	2.13	8.21	16.05	1.92	26.18
817	" Potato Phosphate	13.40	2.01	5.42	4.57	3.93	13.92	9.99	6.89	6.23	17.09	7.40	30.72
721	" Square Brand Bone and Potash	5.76	1.54	1.91	5.16	8.00	15.07	7.07	2.32	4.77	14.02	2.09	20.88
760	" Sure Crop Bone Phosphate	12.62	.98	7.09	3.53	3.95	14.57	10.62	1.10	3.04	18.21	0.99	22.24

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
689 775	Bradley's Complete Manure	Bradley Fertilizer Co., Boston, Mass.	Bangor Gorham	689 775
690 713	Bradley's Eureka Seeding Down Fertilizer	" " " "	Bangor Belfast	690 713
691 714 725	" Potato Manure	" " " "	Bangor Belfast Augusta	691 714 725
692 712 726	" X. L. Superphosphate	" " " "	Bangor Belfast Augusta	692 712 726
820	Buffalo Fertilizer	Milsom Rendering and Fert. Co., East Buffalo, N. Y.	Gardiner	820
753	" Hop, Tobacco and Potato Phosphate	" " " " " " "	Houlton	753
765 771	" New Rival Amm. Superphosphate	Wheeler & Sheldon, General Agents, Rutland, Vt.	Dexter Windham Ctr.	765 771
755 793 837	Clark's Cove Bay State Fertilizer	John S. Reese & Co., New Bedford, Mass.	Houlton Portland Bangor	755 793 837
715 836	" G. G. Fertilizer	" " " " "	Rockland Bangor	715 836
779 790	" Bay State Seeding Down Fertilizer	" " " " "	S. Berwick Portland	779 790

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid. Soluble %	Phosphoric Acid. Reverted %	Phosphoric Acid. Insoluble %	Phosphoric Acid. Total %	Phosphoric Acid. Available %	Potash %	Station Valuation. Value of nitrogen $	Station Valuation. Value of phosphoric acid $	Station Valuation. Value of potash $	Station Valuation. Total valuation $
689	Bradley's Complete Manure	11.25	3.60	5.85	2.44	2.25	10.54	8.29	6.49	11.90	13.92	5.84	31.66
690	" Eureka Seeding Down Fertilizer	9.04	2.06	2.61	2.94	7.00	12.55	5.55	2.31	6.30	11.39	2.08	19.86
691	" Potato Manure	12.83	2.76	4.99	2.23	2.15	9.37	7.22	5.14	8.56	12.18	4.63	25.37
692	" X. L. Superphosphate	13.77	2.71	7.39	2.94	1.60	11.93	10.33	2.21	8.83	16.87	1.99	27.69
820	Buffalo Fertilizer	8.67	2.38	5.28	1.32	2.43	9.03	6.60	1.41	7.38	11.40	1.27	20.05
753	" Hop, Tobacco and Potato Phosphate	9.93	2.43	5.35	1.47	2.17	8.99	6.82	4.92	7.53	11.63	4.43	23.59
765	" New Rival Amm. Superphosphate	12.10	1.46	6.05	3.34	2.11	11.50	9.39	1.31	4.53	15.53	1.18	21.23
755	Clark's Cove Bay State Fertilizer	14.84	2.70	4.16	5.58	.93	10.67	9.74	2.16	8.66	15.40	1.94	26.00
715	" G. G. Fertilizer	13.67	1.93	3.97	6.49	.63	11.09	10.46	1.54	5.98	16.33	1.39	23.70
779	" Bay State Seeding Down Fertilizer	12.28	1.81	3.07	4.71	4.54	12.32	7.78	2.78	5.61	13.82	2.50	21.93

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
769	Crocker's Amm. Corn Phosphate	Wheeler & Sheldon, Gen'l Agents, Rutland Vt.	Dexter	769
772			Windham Ctr.	772
777			S. Berwick	777
688	Cumberland Bone Superphosphate	Cumberland Bone Co., Portland, Me.	Bangor	688
710			Belfast	710
730	Cumberland Potato Fertilizer	" " " " "	Presque Isle	730
750			Ft. Fairfield	750
818			Richmond	818
827	Cumberland Seeding Down Fertilizer	" " " " "	Skowhegan	827
719	Dirigo Fertilizer	Sagadahoc Fertilizer Co., Bowdoinham. Me.	Bowdoinham	719
764			Dexter	764
826			Skowhegan	826
751	Economical Bone Fertilizer	Williamson & Co.	Ft. Fairfield	751
728	E. F. Coe's Amm. Bone Superphosphate	E. Frank Coe, New York, N. Y.	Augusta	728
821			Skowhegan	821
706	E. F. Coe's Grass and Grain Superphosphate	" " " " "	Belfast	706
729			Augusta	729
752			Houlton	752
711	E. F. Coe's High Grade Amm. Bone Superphos	" " " " "	Belfast	711
746			Ft. Fairfield	746
822			Skowhegan	822
747	E. F. Coe's Potato Fertilizer	" " " " "	Ft. Fairfield	747

RESULTS OF ANALYSES.

Station Number.	Brand.	% Moisture	% Nitrogen	Phosphoric Acid.					% Potash	Station Valuation.			
				% Soluble	% Reverted	% Insoluble	% Total	% Available		$ Value of nitrogen	$ Value of phosphoric acid	$ Value of potash	$ Total valuation
769	Crocker's Amm. Corn Phosphate	12.50	2.14	5.35	4.85	2.20	12.40	10.20	1.36	6.63	16.71	1.22	24.56
688	Cumberland Bone Superphosphate	9.12	2.31	5.00	5.91	3.42	14.33	10.91	2.28	7.16	18.23	2.38	27.77
730	Cumberland Potato Fertilizer	8.59	2.81	4.76	5.56	3.13	13.45	10.32	6.43	8.71	17.33	5.79	31.71
827	" Seeding Down Fertilizer	6.09	1.59	2.48	6.11	10.52	19.11	8.59	.90	4.93	17.33	.81	23.37
719	Dirigo Fertilizer	6.40	3.62	.08	1.58	3.46	5.12	1.66	4.20	11.22	3.88	3.78	18.88
751	Economical Bone Fertilizer	7.32	1.02	4.40	2.30	1.18	7.88	6.70	2.32	3.16	10.94	2.09	16.19
728	E. F. Coe's Amm. Bone Superphosphate	10.71	1.74	7.93	2.15	1.70	11.78	10.08	1.20	5.39	16.59	1.21	23.19
706	" Grass and Grain Fertilizer	14.16	.60	9.59	2.23	1.06	12.88	11.82	1.24	1.86	19.10	1.36	22.32
711	" High Grade Amm. Bone Superphosphate	9.36	2.36	8.29	2.12	1.39	11.80	10.41	2.12	7.74	17.00	2.33	27.07
747	" Potato Fertilizer	10.24	2.24	7.00	1.32	1.20	9.52	8.32	5.87	7.36	13.66	5.28	26.30

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
767	E. F. Coe's Standard Brand....................	E. Frank Coe, New York, N. Y..	Dexter........	767
695	Farrar's Potato Phosphate.........	F. S. Farrar & Co., Bangor, Me.,	Bangor....	695
696 839	" Superphosphate......	" " " " "	Bangor.. ...... Brewer.........	696 839
722	Gloucester Fish and Potash....................	Bowker Fertilizer Co., Boston, Mass.,	Bowdoinham ..	722
759 792 833	King Phillip's Alkaline Guano.......	John S. Reese & Co., New Bedford, Mass.,	Dover......... Portland........ Oxford.........	759 792 833
756	May Flower Fertilizer..........	" " " "	Houlton........	756
705 800	Nobsque Guano..........	W. D. Stewart & Co., Boston, Mass.,	Belfast.. ...... Portland........	705 800
823	Original Coe's Superphosphate of Lime.........	Bradley Fertilizer Co., Boston, Mass.,	Skowhegan.. ..	823
741 754 780	Pilgrim Fertilizer............................	John S. Reese & Co., New Bedford, Mass.,	Caribou...... .. Houlton........ S. Berwick.....	741 754 780
783 749 768	Potato, Tobacco and Hop Phosphate...........	Wheeler & Sheldon, Gen'l Agents, Rutland, Vt.,	Presque Isle... Ft. Fairfield... Dexter.........	783 749 768
698 739 781 805	Potato Phosphate..........	Williams & Clark Co., New York, N. Y.,	Belfast.. .... .. Caribou........ Kennebunk.. .. Oxford.........	698 739 781 805

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid. Soluble %	Reverted %	Insoluble %	Total %	Available %	Potash %	Station Valuation. Value of nitrogen $	Value of phosphoric acid $	Value of potash $	Total valuation $
767	E. F. Coe's Standard Brand	10.07	1.76	8.21	2.07	1.39	11.67	10.28	1.10	5.46	16.83	1.21	23.50
695	Farrar's Potato Phosphate	12.16	2.56	4.76	4.86	3.11	12.73	9.62	1.89	8.20	16.15	1.70	26.05
696	" Superphosphate	10.52	2.76	5.95	4.06	3.04	13.05	10.01	1.87	8.56	16.83	1.68	27.07
722	Gloucester Fish and Potash	11.45	1.01	6.74	3.87	3.86	14.47	10.61	1.08	3.13	18.12	.97	22.22
759	King Phillip's Alkaline Bone	12.45	1.80	3.17	5.02	3.86	12.05	8.19	2.90	5.58	14.14	2.61	22.33
756	May Flower Fertilizer	12.05	2.21	5.54	3.80	3.25	12.59	9.34	2.07	6.85	15.86	1.86	24.57
705	Nobsque Guano	4.87	1.15	6.17	2.22	1.71	10.10	8.39	1.72	3.56	13.88	1.92	19.36
823	Original Coe's Superphosphate of Lime	10.15	2.29	7.37	2.02	2.42	11.81	9.39	2.41	7.10	15.79	2.17	25.06
741	Pilgrim Fertilizer	14.62	1.81	4.26	4.48	2.88	11.62	8.74	2.42	5.61	14.69	2.18	22.48
783	Potato, Tobacco and Hop Phosphate	12.54	2.13	6.51	3.25	2.41	12.17	9.76	3.16	6.60	16.25	2.84	25.69
698	Potato Phosphate	11.26	2.74	5.10	1.99	2.00	9.09	7.09	4.77	8.49	11.94	4.29	24.72

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
736	Powell's Prep'd Chemicals for Potatoes and Veg.	W. S. Powell & Co.,	East Washburn	736
799	Quinnipiac Grass Fertilizer	Quinnipiac Grass Fertilizer Co., New London, Conn.	Portland	799
773 783 788	" Phosphate	" " " " " "	Gorham Biddeford Knightsville	773 783 788
701 732 745	" Potato Manure	" " " " " "	Belfast Presque Isle Ft. Fairfield	701 732 745
774 797	" Seeding Down Manure	" " " " " "	Gorham Portland	774 797
791	Reese Concentrated Potato and Corn Manure	John S. Reese & Co., New Bedford, Mass.,	Portland	791
699 801	Royal Bone Phosphate	Williams & Clark Co., New York, N. Y.,	Belfast Portland	699 801
744 807 819	Sagadahoc Special Potato Fertilizer	Sagadahoc Fertilizer Co., Bowdoinham, Me.,	Ft. Fairfield So. Paris Richmond	744 807 819
716 717 808	" Superphosphate	" " " " "	Bath Bowdoinham So. Paris	716 717 808
697 735 740	Soluble Pacific Guano	W. D. Stewart & Co., Boston, Mass.	Belfast Presque Isle Caribou	697 735 740

RESULTS OF ANALYSES.

Station Number.	Brand.	% Moisture	% Nitrogen	Phosphoric Acid. % Soluble	% Reverted	% Insoluble	% Total	% Available	% Potash	Station Valuation. $ Value of nitrogen	$ Value of phosphoric acid	$ Value of potash	$ Total valuation
786	Powell's Prepared Chemicals for Potatoes and Vegetables	11.04	1.77	5.33	1.20	.52	7.05	6.53	6.38	6.15	10.51	5.74	22.43
799	Quinnipiac Grass Fertilizer	21.97	3.41	2.72	4.94	1.91	9.57	7.66	2.91	10.57	12.52	2.62	25.71
778	" Phosphate	16.68	2.98	3.13	9.19	1.84	14.16	12.32	1.86	9.49	19.52	1.67	30.68
701	" Potato Manure	11.17	2.71	5.32	1.78	1.84	8.94	7.10	5.17	8.40	11.92	4.65	24.97
774	" Seeding Down Manure	16.12	1.45	4.35	6.71	1.83	12.89	11.06	2.03	4.49	17.75	1.84	24.08
791	Reese Concentrated Potato and Corn Manure	12.90	3.04	4.38	3.18	.09	8.25	7.56	8.19	9.42	12.05	7.37	28.84
699	Royal Bone Phosphate	9.43	1.28	6.22	2.49	1.30	10.01	8.71	1.84	8.97	14.20	1.92	20.09
744	Sagadahoc Special Potato Fertilizer	9.28	3.37	4.58	1.06	.83	6.47	5.64	4.52	11.29	9.25	4.54	25.08
716	" Superphosphate	10.60	3.01	7.37	1.66	.67	9.70	9.03	2.49	9.24	14.54	2.24	26.72
697	Soluble Pacific Guano	12.42	2.76	6.74	2.39	2.26	11.39	9.13	2.62	8.56	15.26	2.36	26.18

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
707	Standard A Brand Seeding Down Fertilizer....	Standard Fertilizer Co., Boston, Mass.,	Belfast..	707
804			Cumberland Ct.	804
815			Portland	815
709	“ Fertilizer..............	“ “ “ “ “	Belfast	709
748			Fort Fairfield..	748
757			Houlton.	757
802			Cumberland Ct.	802
708	“ Guano......	“ “ “ “ “	Belfast.........	708
742			Ft. Fairfield. ..	742
808			Cumberland Ct.	808
694	Stockbridge's Corn, Grain and Fod. Corn Manure	Bowker Fertilizer Co., Boston, Mass.,	Bangor..	694
724			Bowdoinham ..	724
762			Foxcroft	762
814	“ Grass Top Dressing......	“ “ “ “ “	Bridgton	814
818	“ Manure for Fruit......	“ “ “ “ “	Bridgton	818
809	“ “ “ Beans.........	“ “ “ “ “	Harrison.......	809
785	“ “ “ Seeding Down.......	“ “ “ “ “	Saco.......	785
825			Skowhegan	825
693	“ Potato and Vegetable Manure....	“ “ “ “ “	Bangor...... ..	693
734			Presque Isle...	734
763			Foxcroft	763
812			Bridgton.......	812
758	Sturtevant's Granulated Tobacco and Sulphur..	F. C. Sturtevant, Hartford, Conn.,	Dover.	758
816			Portland.	816
824			Skowhegan	824
810	World of Good Raw Bone Superphosphate	Thompson & Edwards Fertilizer Co.,	Harrison.......	810

RESULTS OF ANALYSES.

Station Number.	Brand.	% Moisture	% Nitrogen	Phosphoric Acid.					% Potash	Station Valuation.			
				% Soluble	% Reverted	% Insoluble	% Total	% Available		$ Value of nitrogen	$ Value of phosphoric acid	$ Value of potash	$ Total valuation
707	Standard A Brand Seeding Down Fertilizer	11.51	1.60	5.58	1.19	3.35	10.12	6.77	1.55	4.96	12.05	1.39	18.40
709	" Fertilizer	14.30	2.19	6.78	2.41	2.35	11.54	9.19	2.42	6.79	15.40	2.18	24.37
708	" Guano	11.75	1.17	5.95	2.39	2.25	10.59	8.34	1.87	3.63	14.00	1.68	19.31
694	Stockbridge's Corn, Grain and Fodder Corn Manure	10.41	3.22	6.35	1.90	2.71	10.96	8.25	4.83	9.98	14.09	4.35	28.42
814	" Grass Top Dressing	8.47	4.73	1.28	4.05	7.71	13.04	5.33	5.53	14.66	11.20	4.98	30.84
818	" Manure for Fruit	7.60	2.83	6.91	2.38	3.30	12.59	9.29	4.38	8.77	15.95	4.67	29.39
809	" " " Beans	10.25	3.48	6.01	2.44	2.10	10.55	8.45	6.86	11.10	14.12	6.18	31.40
785	" " " Seeding Down	9.35	3.19	4.52	2.68	4.91	12.11	7.20	3.91	9.89	13.21	3.52	26.62
693	" Potato and Vegetable Manure	10.67	3.39	5.42	4.27	2.06	11.75	9.69	5.65	10.51	15.89	5.08	31.48
758	Sturtevant's Granulated Tobacco and Sulphur	4.77	2.35				.88		7.38	7.28	1.00	8.11	16.40
810	World of Good Raw Bone Superphosphate	4.59	2.14	5.85	3.30	3.48	12.63	9.15	1.85	6.63	15.70	1.66	23.99

No one who is familiar with the published list of fertilizers that are sold in several states can have failed to notice, not only that there is great multiplicity of brands, but that the names of the various mixed fertilizers indicate that they are to be used for special purposes. We have fertilizers for no special purpose, but for general use, those for corn, for potatoes, for grain, for fruit, for lawns, for top dressing, for seeding down and for various other purposes, if we may regard the names as meaning anything. It is not known to what extent farmers give attention to these names, but it is hoped that they have already learned that they are largely a trade expedient by means of which manufacturers hope to increase their sales. To be sure, potato manure usually contains more than an average amount of potash, and seeding down manures more than the ordinary percentage of insoluble phosphoric acid, but this signifies nothing when we find how slight the difference is between certain corn fertilizers and certain potato "phosphates." These fertilizers are not compounded in accordance with any well defined principle.

No facts are known with regard to the composition of soils or the nutrition of plants which warrant the use of less phosphoric acid and more of nitrogen and potash in a fertilizer for beans than in one for potatoes, as is done in one case. In fact, if we are to judge this matter of special fertilizers by the composition of these goods as we find them in the market, the whole thing appears to be farcical or a species of humbuggery. It is just as sensible to buy some corn manures for use on potatoes, and some potato manures for use on corn as it is to apply them in accordance with their names. The great and controlling factor which should determine what fertilizers are to be purchased is the needs of the soil, and each farmer should purchase manure rich in potash or poor in potash, according to the teaching of his experience.

THE QUALITY OF THE NITROGENOUS MATERIAL IN THE SUPERPHOSPHATES SOLD IN MAINE.

In 1889, this Experiment Station tested the quality of the organic nitrogenous material found in the fertilizers sold in Maine, using the only method which appears to promise fairly reliable results.

There was published in connection with the results of the work of that year an explanation of the needs and methods of such a test, part of which is reproduced in this connection.

Experiment stations have assumed that the organic nitrogen of mixed fertilizers is supplied in the best forms, and have valued it accordingly, but it has been recognized, at the same time, that some way of detecting inferior forms is extremely desirable. The method for doing this which has received most attention, is based upon the different degrees of solubility of organic nitrogen compounds in a pepsin solution. The nitrogen of dried blood, dried flesh, cotton-seed meal and similar high grade nitrogenous materials, is very largely dissolved by digestion in a pepsin solution, while that of horn, hoof and leather is much less affected by this treatment.

In support of this statement, there is given below the results of experiments conducted in three different laboratories for the purpose of testing the value of this method. With regard to most of the materials used, these results are practically in accord.

SOLUBILITY OF CERTAIN NITROGENOUS MATERIALS IN PEPSIN SOLUTION.

MATERIALS USED.	Per Cent. of Total Nitrogen Dissolved as found by		
	Shepard & Chazal.	Conn. Expt. Sta.	Maine Expt. Sta.
Dried Blood	99.8 78.6 } 89.2	96.8 97.9 } 97.3	97.3 93.3 97.6 95.1 } 95.8
Cotton Seed Meal	83.2 85.7 83.1 } 84.0	92.7	
Ground Bone		52. to 99.* av. 78.	68.8
Dried Flesh	93.3	78.7 85.4 77.5 } 80.5	75.7 75.4 78.4 } 76.5
Dried Fish		58. to 72.† av. 66.	
Fish Scrap	88.6 84.6 } 86.6		59.2 82.6 } 70.9
Tankage	61.3		58.0 48.6 } 53.3
Wool Waste		4.3	
Leather	37.8	25.4 35.9 33.3 } 34.0	26.5 7.7 } 17.1
Horn and Hoof Meal		7.2 22.4 28.2 } 19.3	25.6

* 20 samples. † 7 samples.

The degree of solubility for cheap and inferior "ammoniates" such as horn, hoof, leather and wool waste is seen to vary from 4.8 per cent. to 37.8 per cent., while in the case of dried blood, cotton-seed meal, dried and ground flesh, dried fish, fish scrap and ground bone the average percentages of the different trials range from 70.9 per cent. to 97.3 per cent. It is shown by the Conn. Experiment Station* that mixing with these ammoniates mineral compounds of the kind and in the quantity that would be found accompanying them in superphosphates does not materially change their solubility in a pepsin solution, consequently it is fair to conclude that the solubility in a pepsin solution of the organic nitrogen of a superphosphate will show whether this ingredient is furnished largely in an inferior form.

It was found in 1889, that the percentage of nitrogen soluble in a pepsin solution varied in the several brands tested from thirty-eight to seventy-eight per cent. This variation most certainly indicated a radical difference in the character of the ammoniates used by the various manufacturers, and it was thought wise to repeat this work with the goods offered for sale in 1891. Not every brand of which samples have been taken in the market has been submitted to this test, but there has been selected for this purpose at least one brand from each manufacturer selling goods in the State. The work was performed by Mr. Merrill with the use of the following methods:

The sample taken to represent a brand of superphosphate was made up so as to represent the average of all the samples of that brand selected this season. This was done, for instance in the case of the Bay State Fertilizer, by weighing out equal quantities of Nos. 755, 793 and 837, and thoroughly mixing them in a mortar. One gram of substance was thoroughly leached with water and then submitted to the action of a pepsin solution in accordance with the method given below. The insoluble nitrogen of the residue was then determined.†

The percentages of organic nitrogen given are the total nitrogen minus the nitrogen as nitric acid and ammonia. The tables which follow explain themselves.

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† The method of treating the substances was briefly as follows: The pepsin solution was made by dissolving 5 grams of scale pepsin in 1000 c. c. of .2 per cent. hydrochloric acid. Two grams of the substance were digested for 12 hours on each of two consecutive days with 200 c. c. of this solution, at a temperature of 40 degrees C. During the time of digestion 2 c. c. of a ten per cent. solution of hydrochloric acid were added at regular intervals until the digestive fluid contained one per cent. of the acid.

[Report Conn. Experiment Station, 1885, pp. 120-121.]

	Per Cent. of Nitrogen in Fertilizer.				Solubility in Pepsin Solution.		
	Nitrogen as Nitric Acid.	Nitrogen as Ammonia.	Organic Nitrogen.	Total Nitrogen.	Organic Nitrogen Soluble in Pepsin: % in Fertilizer.	% of Org. Nitrogen Soluble in Pepsin Solution.	% of Total Nitrogen soluble in Water and Pepsin Solution.
Allen's Fertilizer for Lawn......		.91	1.68	2.59	.59	35.1	57.9
Bay State Fertilizer..............		.49	2.21	2.70	1.54	69.7	75.2
Bowker's Potato Phosphate......	.47		1.54	2.01	1.00	64.9	73.1
Bradley's Potato Manure.........	.37		2.39	2.76	1.50	62.8	67.8
Buffalo Hop, Tobacco and Potato Phosphate.......		.25	2.18	2.43	1.64	75.2	77.8
Buffalo Potato, Tobacco and Hop Phosphate.........		.26	1.87	2.13	1.12	59.9	64.8
Cumberland Bone Superphosphate	.26	.21	1.84	2.31	1.04	56.5	65.4
Dirigo Fertilizer.................		.22	3.40	3.62	1.48	43.5	47.0
E. Frank Coe's Potato Fertilizer..		.70	1.54	2.24	.86	55.8	69.6
Farrar's Potato Superphosphate..		.43	2.13	2.56	1.42	66.7	72.3
Nobsque Guano..................			1.15	1.15	.62	53.9	53.9
Original Bay State Superphos....		.25	2.34	2.59	1.56	66.7	69.9
Powell's Prepared Chemicals for Potatoes and Vegetables.......	.57	1.11	.09	1.77	—	—	—
Quinnipiac Grass Fertilizer......	.82	.32	2.27	3.41	1.18	52.0	68.3
Quinnipiac Phosphate............	.46	.43	2.09	2.98	1.15	55.0	68.5
Quinnipiac Potato Manure.......	.61	.21	1.89	2.71	1.27	67.2	77.1
Sagadahoc Special Potato Fertilizer..............................		1.40	1.97	3.37	.99	50.2	70.9
Sagadahoc Superphosphate for Hill and Drill......		1.03	1.98	3.01	1.07	54.0	69.8
Standard A Brand Seeding Down		.30	1.30	1.60	.81	62.3	69.4
Standard Fertilizer...............		.20	1.99	2.19	1.21	60.8	64.4
Standard Guano..................		.16	1.01	1.17	.63	62.4	67.5
Stockbridge Manure, Corn, Grain and Fodder......	1.41		1.81	3.22	1.20	66.3	81.1
Williams & Clark Potato Phos....	.47		2.27	2.74	1.52	67.0	72.6
World of Good Raw Bone Superphosphate.......			2.14	2.14	1.68	78.5	78.5

The solubility of the organic material in various fertilizers in a pepsin solution varies from thirty-five per cent. to seventy-eight per cent.

In the case of several brands, the figures are such as to cause grave doubts as to whether the manufacturers are not using what are regarded as low grade ammoniates, that is, ammoniates coming from such materials as hoof, horn, leather &c., of which we have reason to suppose that they will decompose slowly in the soil and are therefore poorly adapted for use with quickly growing plants. It is at least safe to affirm that with a large number of these fertilizers the solubility of the organic matter comes far short of that which dried blood, cotton seed meal, dried flesh and similar materials are known to have.

STATION EQUIPMENT.

The Maine Experiment Station, since its organization in 1885, has devoted a fair share of its income and of the time of its working force to a study of some of the practical problems pertaining to animal nutrition. During all this time the equipment for this work has been gradually improving, until it has become quite satisfactory for conducting experiments in determining the digestibility of cattle foods and in testing the economy of various methods and rations for producing meat and milk.

A description of the Station Barn is given here, not because its arrangement and equipment are regarded as especially good, but because the interest of those who are following the Station work may be increased possibly by a definite understanding of just how and where this work is done.

THE STATION BARN.

This is a building (see cut) one hundred feet long by forty feet wide. It consists of a basement, the first floor, which is devoted to space for tying animals and to other necessary rooms, and the second story, which gives sufficient room for the storing of fodder and numerous lots of experimental grain. The foundation of the barn, which constitutes the walls of the basement and which rests for its entire length upon a solid ledge, is built of broken stone and is thoroughly cemented on the outside and well filled with mortar on the inside.

The floor of the basement consists of solid ledge covered by a small amount of earth, and has sufficient inclination to entirely prevent any standing water, even if such were to come from outside drainage, which is not the case.

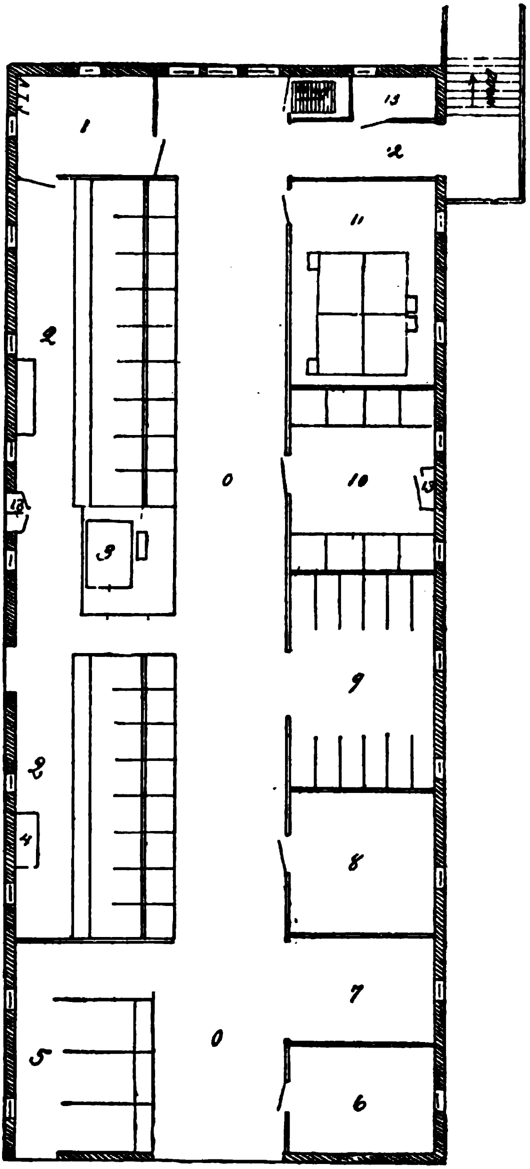
The first floor of the barn is occupied as follows (see Plate I):

(0) A driveway and floor for feeding which occupies the center of the entire length of the barn. This floor space is covered by an upper floor with the exception of about twenty feet at one end.

(1) A hospital in the southwest corner of the barn.

(2) A tie-up on the south side of the barn which has seventeen stalls. This tie-up is provided with scales (3) set in the floor for

PLATE I



FIRST FLOOR EXPERIMENT STATION BARN.

0. Driveway.
1. Hospital.
2. Cow Stable.
3. Scales.
4. Water.
5. Horse Stable.
6. Silo.
7. Storage.
8. "
9. Hay Bins.
10. Grain Room.
11. Digestion Room.

the purpose of weighing experimental animals. It is also supplied with running water (4). The stalls are built of birch and are so constructed as to give the animal the utmost ease in its movements. (See cut.) The manure drops through trap doors into the basement.

(5) Horse stalls to accommodate the horses of such station officers as live at a distance from the College buildings.

(6) The silo in the northeast corner which extends from the floor of the basement to the second floor above.

(7) Space for the storage of implements.

(8) A room for the storage of fertilizers, grains, etc.

(9) Small bins into which the hay rations of experimental animals are weighed.

(10) The grain room, equipped with a number of grain bins and scales for the weighing of rations.

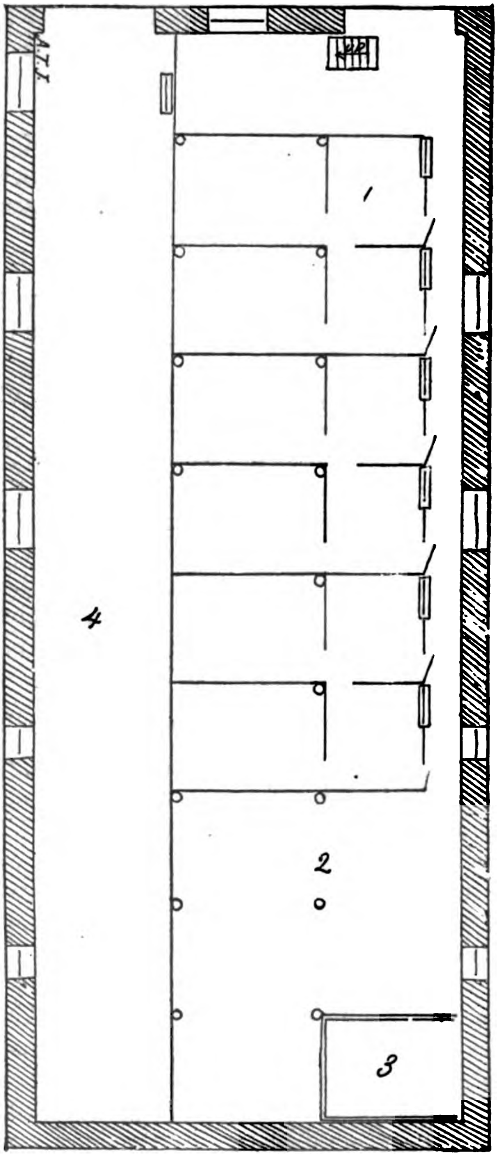
(11) A room devoted to digestion experiments.

The walls of these various rooms as well as the partitions between them and the feeding floor consist of spruce sheathing. The use of the second floor has already been stated. The hay or grain is taken from the load (which is driven into the end of the barn that is not floored over) by a fork, which, running on a track near the ridgepole of the barn, distributes the hay to any desired point.

FEEDING EXPERIMENTS WITH COWS AND OTHER BOVINES.

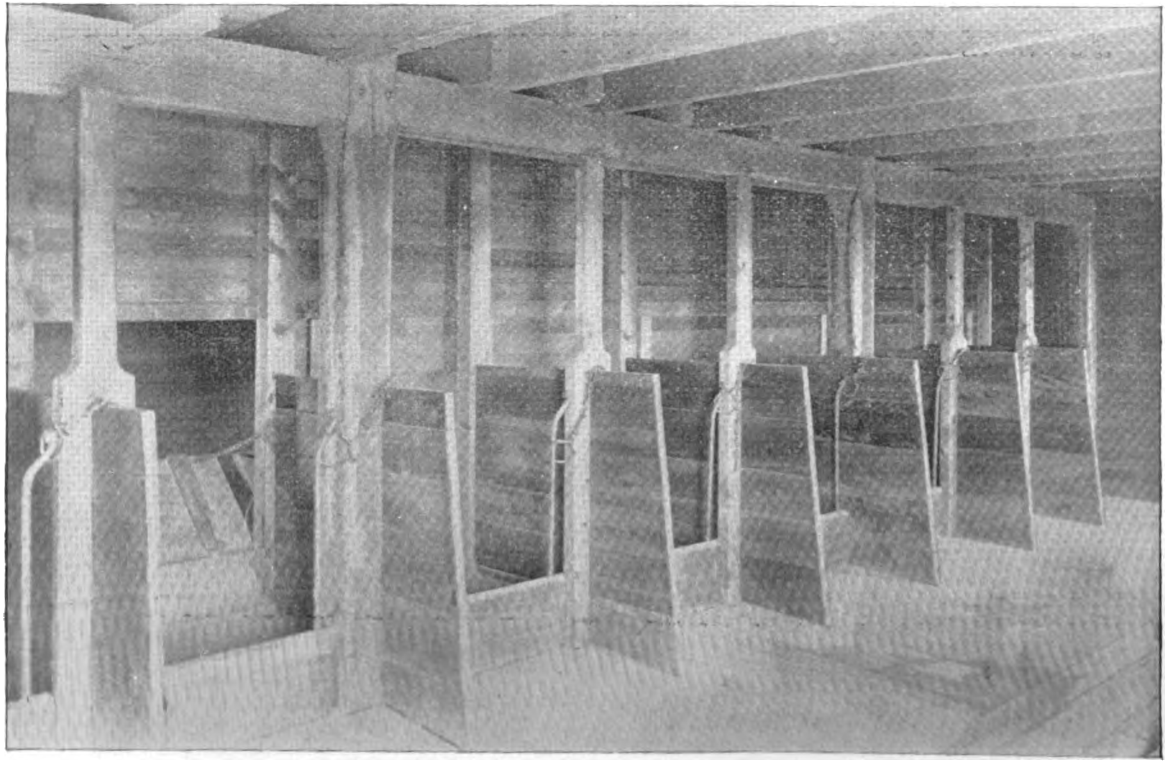
These experiments usually involve both the feeding of a fodder and a grain ration. The fodder, if hay, is generally weighed out in lots of fifty pounds and stored in the bins provided for that purpose. Each bin is set aside to the use of a certain animal, and a cow, for instance, is fed from her particular bin until it is necessary to weigh out a new portion of hay. By adopting this method it is possible to avoid such numerous weighings as would be required if the fodder was weighed each time the animal is fed. In the grain room are found boxes which are marked with either the numbers or names of the animals, into which each portion of grain is weighed. When this grain is fed it is turned into the stalls, the bottoms of which are so constructed that there is no waste. Generally the rations, both of fodder and grain, are entirely consumed, but if such is not the case, the uneaten portions are saved and weighed, so that it is possible to calculate the amounts actually eaten. If the experiment is with growing ani-

PLATE II.



BASEMENT EXPERIMENT STATION BARN.

1. Pig Pens.
2 Storage.
3. Silo.
4. Manure.



COW STALLS IN EXPERIMENT STATION BARN.

mals, not only is there a daily weighing of rations, but the weight of the animals must be ascertained at the beginning and end of the several feeding periods. The animals are usually weighed on several successive days and the average of these weights is taken as a basis for calculating the amount of growth.

If an experiment is being made with dairy cows, not only is it necessary to weigh the rations and also to keep a record of the weights of the cows, but the weight of each mess of milk must be recorded. The weights of milk are marked on prepared blanks which are hung in a convenient place behind the animals. In all such experiments the appetite and health of the animals are carefully watched and the results with any animal that is not in proper condition are not allowed to enter into the final published records. The experimental animals, whether young stock or dairy cows, are allowed a proper amount of exercise in a yard which lies on the sunny side of the barn. A portion of the partition which separates the tie-up from the feeding floor is hinged, so that one part can be let down and another part turned up. In this way, it is possible to give proper ventilation and to some extent, control the temperature where the animals are standing.

SWINE FEEDING EXPERIMENTS.

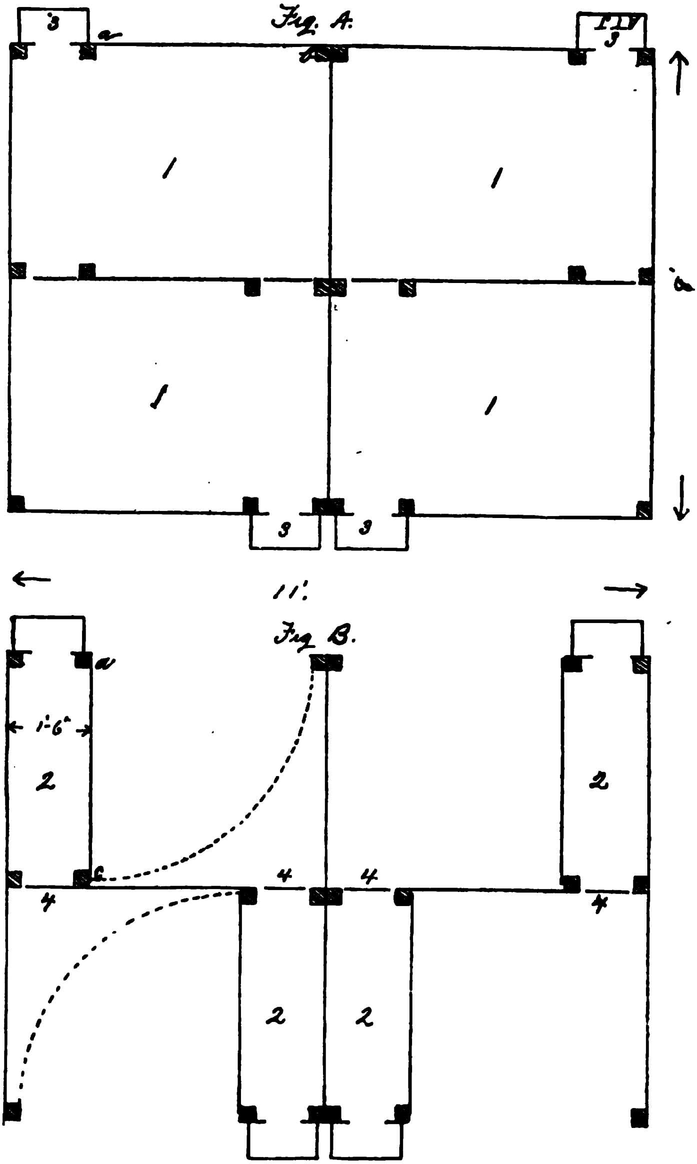
These experiments are to be carried on in the future in six pens which have lately been built in the basement (see Plate II). These pens are divided into two rooms which are connected by a sliding door, one room having a floor of spruce plank. This latter part is well littered with straw and is intended for the place where the animals shall eat and sleep. The feeding troughs are so arranged that by means of a swinging partition the animals can be excluded from them. This device prevents the troughs being filled with filth during the time when the animals are not eating, and allows the attendant to turn in the food without inconvenience. After the food is turned in, the partition is swung to the outside of the trough, and when the animal has finished his meal, is swung back again.

THE DIGESTION ROOM.

The mechanical appliances which must be considered in connection with a digestion experiment, are

(1) The pen or stall in which the animal is kept.

PLATE III.



PENS FOR DIGESTION EXPERIMENTS WITH SHEEP.

1. Pens, with sheep at liberty.
2. " " " confined.
3. Feeding Boxes.
4. Sliding Panels

(2) The rubber bag and harness which are attached to the animal during the time that it is necessary to collect the excrements.

The form of the stall or pen depends upon the kind of animal used. The digestion trials made by this Station have been almost entirely with sheep, and the pen shown in the accompanying plate was devised here for use with this animal. The sides of these pens are 3'—9'' high and are built of four inch spruce sheathing, with spaces.

As can be seen by reference to Plate III, the pens are so constructed that four sheep can be used at one time. As shown in Fig. A, each pen has a floor space of twenty-two square feet.

In Fig. B nearly all of one side of each pen has been swung from the position *a b* to the position *a c*, forming a stall 18x48 inches in dimensions, in which the sheep can stand and lie at ease but cannot turn around.

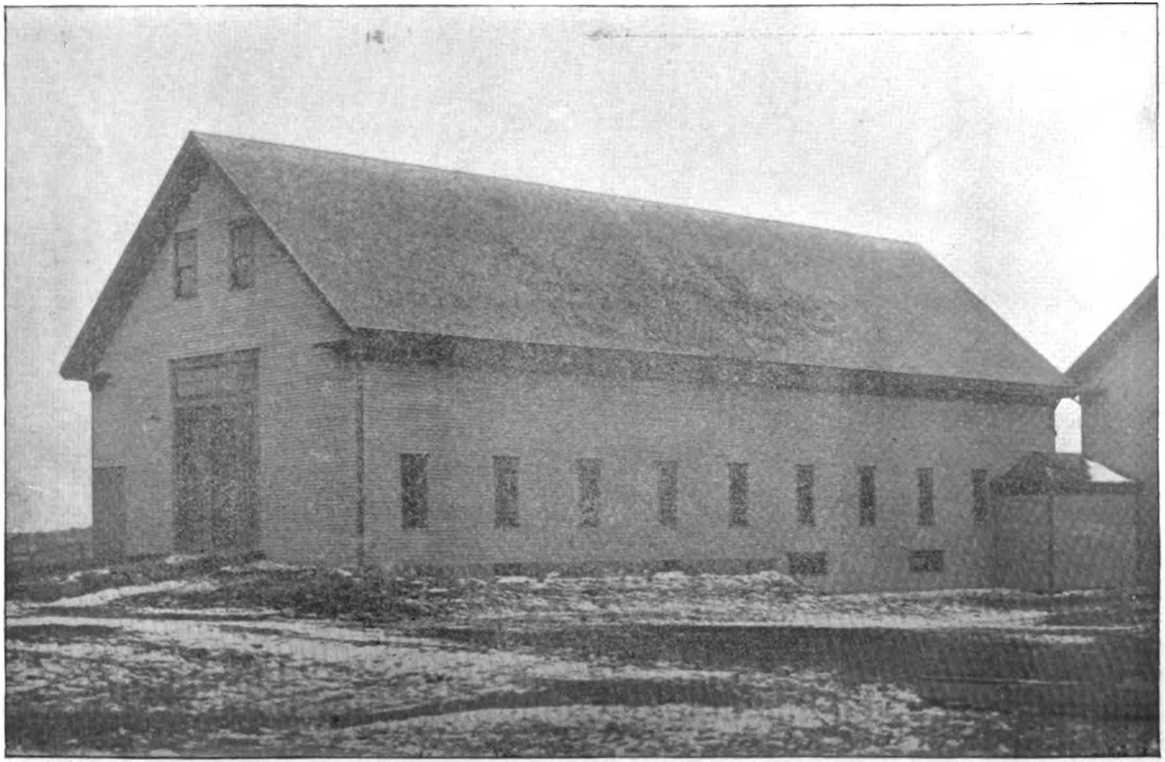
It is well known to those familiar with the methods of digestion experiments that a feeding period of from twelve to fourteen days is necessary, at least the first seven days of which must be devoted to a preliminary feeding before it is safe to collect the excrement. During this first seven days the animal may have the liberty of the pen as shown in Fig. A. When, however, the excrement bags are attached it is necessary to confine the animals in the stalls as shown in Fig. B, either during the entire five days or at least while the contents of the bags are being removed.

During the last five days, while confined in the smaller pens, the animals stand upon a movable slat floor, the spaces between the slats allowing the urine to flow out of the way so that neither the animal nor the bags become soiled. The outer end of each of the small pens. contains an aperture through which the animal's head has access to the feeding boxes which are attached outside. These feeding boxes are wooden boxes lined with zinc, which are extended upwards with galvanized iron to a height that entirely prevents the scattering of the food outside. The rear end of the smaller pens consists in part of a sliding panel, which allows the convenient removal of the contents of the excrement bags.

During the seven days that the dung is not collected the animals are freely bedded with dry, clean sawdust. When the bags are attached the bedding is removed and the floors thoroughly swept, so that it is possible to see whether any loss of dung has occurred.

The arrangement of these pens has so far proved entirely satisfactory, and is commended to those who desire to undertake digestion experiments.

The excrement bags in use by this Station consist on the inside of the ordinary rubber cloth which can be purchased at any drug store, and on the outside of bed ticking, which gives strength and durability. These bags are attached to the animal by means of a light harness. This harness is made as follows: A collar passes around the animal's neck, and a band around the body just back of the fore legs. To the neck collar are attached four straps which pass lengthwise of the body, two along the back and two between the fore legs. The straps slide through slots in the body band, and are attached to the bag on the back and under the belly just front of the hind legs. The lower end of the bag is not sewed together, but is closed when necessary by tying a string around it. In this way the bags can be emptied by simply untying the string and allowing the contents to drop into a dish placed underneath.



MAINE EXPERIMENT STATION BARN.

DIGESTION EXPERIMENTS.

The digestion experiments, the results of which are given in the following pages, were not wholly accomplished within the year 1891, but were in part performed during the latter part of 1890.

The materials which were made the subject of these experiments were produced on the College Farm in the summer of 1890, excepting, of course, the bran and gluten meal. The mere determination of digestion coefficients was not, in every case, the main object of the work. While a knowledge of the digestibility of these foods is of value in itself, here it was in large part essential to correct conclusions in regard to quite different questions.

Experimental Foods.

The foods whose digestibility was determined were the following:

CXXI. Hungarian Grass.
CXXVIII. Hungarian Hay (cxxi dried).
CXXVII. So. Corn Fodder.
CXXV. Field Corn Fodder.
CXXVI. Sweet Corn Fodder.
CXL. Timothy Hay.
CXLI. " "
CXXXIII. Sugar Beets.
CXXXII. Mangolds.
CXXX. Rutabagas.
CXXXI. English Flat Turnips.
CXXXIV. Gluten Meal.
CXXXV. Wheat Bran.

The gluten meal and wheat bran were purchased in the Bangor market and the other foods were produced by the Station.

Digestibility of Hungarian Grass.

Time of experiment, August and September, 1890.
Animals used, Sheep.
Daily ration, 2250 grams.
Total period, 12 days.
Feces collected, last five days.

A certain amount of the grass was cut daily, from which, after chopping, the rations were weighed. A portion of the fresh grass unchopped was also put aside each day and carefully spread for drying.

Samples for analysis were selected daily and were immediately dried in the laboratory by the aid of steam heat.

Analytical data.—The composition of the fresh grass is given below, as well as that of the water-free material.

COMPOSITION OF HUNGARIAN GRASS.

	Fresh Grass.						Water-free Substance.				
	Water.	Ash.	Protein Nx 6.25	Fiber.	Nitrogen-free extract.	Fat.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
	%	%	%	%	%	%	%	%	%	%	%
CXXI, Hungarian Grass.....	75.29	2.29	2.73	7.58	11.29	.82	9.26	11.07	30.66	45.68	3.33

COMPOSITION OF FECES FROM HUNGARIAN GRASS.

	Fresh Feces.		In 100 parts dry substance.				
	Water.	Dry substance.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
	%	%					
Sheep 1..	65.37	34.63	14.50	11.25	27.15	43.26	3.84
" 2......................... ...	68.48	31.52	14.85	11.97	27.13	41.47	4.58
" 3...........................	52.34	47.66	15.52	10.86	26.74	41.46	4.42
" 4...........................	54.26	45.74	14.22	11.25	26.25	43.83	4.40

WEIGHTS OF FOOD AND FECES.

	Food eaten daily.		Feces excreted daily.	
	Green.	Water-free.	Fresh.	Water-free.
	grams.	grams.	grams.	grams.
Hungarian Grass, Sheep 1.....................	2250	556	626	216.8
" " " 2.......................	"	"	661	208.4
" " " 3.......................	"	"	430	205.0
" " " 4.......................	"	"	400.4	183.2

The digestibility of the Hungarian Grass as calculated from the preceding data was as follows:*

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Sheep, 1	61.	63.4	37.2	60.2	65.4	63.5	54 9
" 2	62.5	65.1	37.	59.4	66.8	66.7	47.8
" 3	63.1	65.2	42.5	63.6	67.2	64.8	50.5
" 4	67.	68.8	49.5	66.4	71.7	68.4	56.
Average	63.4	65.6	41.5	62.4	67.8	65.8	52.3

DIGESTIBILITY OF HUNGARIAN HAY.

Time of experiment, November, 1890.

Animals used, Sheep.

Daily ration, 800 grams air dry hay.

Total period, 12 days.

Feces collected, last five days.

This hay was made from the grass used in the digestion experiment previously described; the grass was dried under cover by spreading it thinly on a scaffold.

Analytical data.—The tables below give the composition of the hay and feces and the weights of materials.

COMPOSITION OF HUNGARIAN HAY.

	Air dry hay.						Water-free substance.				
	Water.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
CXXVIII Hungarian Hay	18.07	7.08	8.86	23.96	38.93	3.10	8.64	10.82	29.24	47.52	3.78

COMPOSITION OF FECES FROM HUNGARIAN HAY.

	Fresh Feces.		In 100 parts dry substance.				
	Water.	Dry substance.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
Hungarian Hay, Sheep, 1	53.29	46.71	12.89	12.42	26.54	44.24	3.90
" " " 3	51.23	48.77	12.87	12.11	27.11	44.08	3.83

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* Tables showing the necessary calculations for these and other coefficients can be found in the appendix to this part of the report.

WEIGHTS OF FOOD AND FECES.

	Food eaten daily.		Feces excreted daily.	
	Air dry.	Water-free.	Fresh.	Water-free.
Hungarian Hay, Sheep 1	800	655.5	490	228.9
" " " 3	800	655.5	480	234.1

The following coefficients of digestibility were obtained with two sheep:

DIGESTIBILITY OF HUNGARIAN HAY.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Sheep, 1	65.8	66.8	47.9	59.9	68.5	67.4	63.9
" 3	64.3	65.9	46.9	60.	66.8	66.9	63.8
Average	**65.**	**66.3**	**47.4**	**60.**	**67.6**	**67.1**	**63.8**
Hung. Grass as previously found	63.4	65.6	35.5	62.4	67.8	65.8	52.3

DIGESTIBILITY OF CORN FODDER FROM SO. CORN, FIELD CORN AND SWEET CORN.

Time of experiment, October and November, 1890.

Animals used, sheep.

Total period, 12 days.

Feces collected, last 5 days.

A determination of the digestibility of the fodders from these varieties of corn was one of the necessary steps in an attempt* to study their relative yield of digestible material.

Several hundred pounds of the green fodder corn were selected from each variety at the time the crop was cut and weighed. These small lots were stored in such a manner that they would dry without moulding and where they were safe from the depredations of mice.

The partially dried fodder of the several kinds was finely chopped, thoroughly mixed, the daily rations weighed out, and samples at once taken to the laboratory, where the drying was completed by steam heat.

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* The details of this experiment are given on subsequent pages.

Analytical data.

COMPOSITION OF THE CORN FODDERS BEFORE DRYING.

	Green Corn.						Water-free substance.				
	Water.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
CXXVII, So. Corn..........	85.06	1.28	1.64	4.58	7.00	.44	8.55	10.99	30.66	46 87	2.93
CXXV, Field Corn..........	84.21	1.20	1.77	4.01	8.28	.58	7.62	11.20	25.42	52.45	3.31
CXXVI, Sweet Corn........	83.85	1.13	2.18	4.14	8.08	.62	7.01	13.52	25.63	49.98	3.86

COMPOSITION OF FECES FROM THE CORN FODDERS.

	Fresh Feces.		In 100 parts dry substance.				
	Water.	Dry substance.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
So. Corn Fodder, Sheep 2.........	60.62	39.38	12.	12.42	25.87	46.81	2.76
" " " " 4.........	53.67	46.33	11.78	12.41	25.76	47.23	2.83
Field Corn Fodder, Sheep 1......	59.90	40.10	11.78	14.08	21.36	49.48	3.30
" " " " 3......	65.81	34.19	12.58	15.01	20.80	48.26	3.35
Sweet Corn Fodder, Sheep 2.....	72.01	27.99	14.42	17.52	19.34	46.04	2.68
" " " " 4.....	69.29	30.71	13.77	16.58	20.19	46.11	3.35

WEIGHTS OF FOOD AND FECES.

	Food eaten daily.		Feces excreted daily.	
	Green.	Water-free.	Fresh.	Water-free.
So. Corn, Sheep 2.....................	3378.8	504.7	380.	149.6
" " " 4.....................	3378.8	501.7	342.	158.4
Field Corn, Sheep 1....................	2553.2	403.2	283.4	113.6
" " " 3....................	2553.2	403.2	360.	123.1
Sweet Corn, Sheep 2...................	2521.	407.2	445.2	124.7
" " " 4...................	2521.	407.2	394.	121.

Below are given the coefficients of digestibility as found:

DIGESTION COEFFICIENTS OF CORN FODDERS.

	Dry substance.	Organic matter.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
So. Corn, Sheep 2	70.3	71.4	58.2	66.1	74.9	70.4	72.3
" " " 4	68.6	69.8	56.6	64.7	73.6	68.7	69.6
Average	**69.4**	**70.6**	**57.4**	**65.4**	**74.2**	**69.5**	**70.9**
Field Corn, Sheep 1	71.8	73.7	56.3	64.6	76.3	73.4	71.4
" " " 8	69.4	71.1	49.5	59.	75.	71.9	69.1
Average	**70.6**	**72.4**	**52.9**	**61.8**	**75.6**	**72.6**	**70.2**
Sweet Corn, Sheep 2	69.3	73.2	37.	60.2	76.9	71.8	78.3
" " " 4	70.2	73.9	41.9	63.5	76.6	72.5	74.5
Average	**69.7**	**73.5**	**39.4**	**61.8**	**76.7**	**72.1**	**76.4**

DIGESTIBILITY OF TIMOTHY HAY.

Time of experiment, December, 1890, and February, 1891.

Animals, Sheep.

Daily rations, 700 grs.

Total period, 12 days.

Feces collected, last five days.

Two large lots of hay were taken from the mows, finely chopped and thoroughly mixed. The digestibility of this material was ascertained as work necessarily preliminary to a determination of the digestibility of various roots, wheat bran and gluten meal. The hay was very nearly all Timothy, a slight mixture of other grasses being present.

Analytical data.

COMPOSITION OF TIMOTHY HAY.

	Air dry hay.						Water-free substance.				
	Water.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
CXL, Timothy Hay	7.63	4.61	6.88	30.15	46.33	4.40	4.99	7.44	32.64	50.17	4.76
CXLI, Timothy Hay	7.63	5.22	6.69	30.34	46.32	3.80	5.65	7.24	32.84	50.16	4.11

COMPOSITION OF FECES FROM TIMOTHY HAY.

	Fresh feces.		In 100 parts dry substance.				
	Water.	Dry substance.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
Timothy Hay, CXL, Sheep 1.........	70.10	29.90	9.01	10.53	36.48	41.19	2.79
" 2.........	54.27	45.73	7.85	9.51	37.53	41.95	3.16
" 3.........	64.26	35.74	8.45	9.87	34.42	44.17	3.11
" 4.........	60.43	39.57	8.69	10.25	29.03	49.19	2.84
Timothy Hay, CXLI, Sheep 1.........	63.46	36.54	8.56	9.34	36.19	43.26	2.65
" 2.........	69.00	31.00	8.77	9.95	37.02	41.33	2.93
" 3.........	56.41	43.59	7.93	8.76	36.13	44.03	3.15
" 4.........	47.55	52.45	8.09	9.17	35.29	43.89	3.56

FOOD EATEN AND FECES EXCRETED.

	Food eaten daily.		Feces excreted daily	
	Air dry.	Water-free.	Fresh.	Water-free.
Timothy Hay. CXL, Sheep 1.........	700	646.6	891.2	266.5
" 2.........	700	646.6	620.	283.5
" 3.........	700	646.6	680.	243.0
" 4.........	700	646.6	700.	277.
Timothy Hay, CXLI, Sheep 1.........	700	646.6	752.	274.8
" 2.........	700	646.6	861.	266.9
" 3.........	700	646.6	614.	267.7
" 4.........	647	594.6	438.	229.7

DIGESTIBILITY OF TIMOTHY HAY.

	Dry matter.	Organic substance.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
Timothy Hay, CXL, Sheep 1......	58.7	60.5	25.7	41.9	53.9	66.1	75.9
" 2......	56.1	57.4	30.9	44.0	49.6	63.3	71.1
" 3......	62.4	63.7	36.5	49.8	60.3	66.9	75.6
" 4......	57.1	58.8	25.4	40.9	61.9	58.0	74.6
Average......................	**58.5**	**60.1**	**29.6**	**44.1**	**56.4**	**63.6**	**74.3**
Timothy Hay, CXLI, Sheep 1.....	57.5	58.8	35.6	45.3	53.1	63.3	72.5
" 2.....	58.7	60.0	35.9	43.3	53.5	65.9	70.7
" 3.....	58.6	59.6	41.9	49.8	54.5	63.7	69.2
" 4.....	61.3	62.3	45.6	51.9	58.3	65.	67.0
Average......................	**59.1**	**60.2**	**39.7**	**47.5**	**54.8**	**64.7**	**69.8**

DIGESTIBILITY OF VARIOUS ROOTS.

Date of the experiment, January, 1891.

Animals used, Sheep.

Daily ration, { 500 grams Timothy Hay (CXL).
2000 grams Roots.

Total period, 12 days.

Feces collected, last five days.

The digestibility of roots with ruminants cannot be determined by feeding a ration composed of them alone. It is necessary, therefore, to feed with them some fodder material like hay, straw, etc. The roots, the digestion coefficients of which have been ascertained by feeding trials during 1890 and 1891, are sugar beets, mangolds, rutabagas and English flat turnips. With these were fed a known quantity of Timothy hay (No. CXL), the digestibility of which had been previously determined. In order to test the four varieties of roots mentioned, it was necessary to employ four animals during two periods.

Analytical Data.

COMPOSITION OF THE ROOTS.

	Water.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
CXXXIII, Sugar Beets.	83.75	1.11	1.56	.87	12.57	.14	6.85	9.60	5.37	77.31	.87
CXXXII, Mangolds....	88.27	1.11	1.24	.73	8.53	.12	9.49	10.56	6.20	72.64	1.01
CXXX, Rutabagas.....	89.05	.72	.89	1.00	7.80	.54	6.58	8.13	9.06	71.29	4.94
CXXXI, Eng. Flat Turnips.................	90.24	.92	1.10	1.02	6.32	.40	9.43	11.28	10.43	64.77	4.09

COMPOSITION OF FECES FROM ROOTS.

	Fresh feces.		In 100 parts water-free substance.				
	Water.	Dry substance.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free substance.	Fat.
Sugar Beets, Sheep 1.............	61.09	38.91	13.69	10.59	32.16	40.25	3.31
" 3.............	54.93	45.07	16.22	10.32	30.34	39.65	3.47
Mangolds, Sheep 2................	58.53	41.47	13.74	10.80	31.13	40.68	3.56
" 4................	53.17	46.83	15.01	10.14	30.05	41.17	3.63
Rutabagas, Sheep 1..............	50.58	49.42	11.24	10.17	31.94	43.56	3.09
" 3..............	50.99	49.01	12.53	10.50	32.60	40.73	3.64
Eng. Flat Turnips, Sheep 2......	54.79	45.21	10.87	10.77	32.35	42.61	3.40
" 4......	79.71	20.29	12.30	10.06	30.84	43.67	3.13

FOOD EATEN AND FECES EXCRETED.

		Food eaten daily.		Feces excreted daily.	
		Airdry and green.	Water-free.	Fresh.	Water-free.
Sheep 1,	Timothy Hay (CXL)	500	461.8	540.8	210.4
	Sugar Beets	2000	325.		
Sheep 3,	" " "	"	"	463.2	208.8
Sheep 2,	Timothy Hay (CXL)	500	461.8	591.8	245.4
	Mangolds	2000	234.6		
Sheep 4,	" " "	"	"	509.2	238.5
Sheep 1,	Timothy Hay (CXL)	500	461.8	432.	213.5
	Ruta Bagas	2000	219.		
Sheep 3,	" " "	"	"	460.	225.5
Sheep 2,	Timothy Hay (CXL)	500	461.8	464.	209.8
	Eng. Flat Turnips	2000	195.2		
Sheep 4,	" " "	"	"	994.	201.6

DIGESTION COEFFICIENTS OF VARIOUS ROOTS.

	Dry substance.	Organic matter.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
Sugar Beets, Sheep 1	94.2	97.6	43.2	90.	88.5	99.8	53.5
" 3	94.8	99.9	20.7	92.6	113.	100.	46.4
Average	94.5	98.7	31.9	91.3	100.7	99.9	49.9
Mangolds, Sheep 2	77.1	82.7	21 1	69.7	26.8	90.8	......
" 4	80.	87.	11.7	79.8	58.8	91.9	......
Average	78.5	84.8	16.4	74 7	42.8	91.3	......
Rutabagas, Sheep 1	90.	93.	45.8	85.9	87.5	94.4	91.6
" 3	84 5	89.2	16.7	74.7	61.	95.1	76.8
Average	87 2	91.1	31.2	80 3	74.2	94.7	84.2
Eng. Flat Turnips, Sheep 2	90.7	93.2	64.1	84 5	89.2	96.	82.5
" 4	94 9	99.	53.2	95.	117.	97.	92.5
Average	92.8	96.1	58.6	89.7	103.	96.5	97.5

DIGESTIBILITY OF GLUTEN MEAL AND WHEAT BRAN.

Time of experiment, February, 1891.

Animals used, Sheep.

Daily ration, { 500 grams Timothy hay,
300 grams grain.

Total period, 12 days.

Feces collected, last five days.

There were two reasons for making digestion experiments with these two commercial cattle foods, viz: No attempt appears to have been made to learn the digestibility of gluten meal, and a former trial gave such unfavorable and somewhat unexpected results with wheat bran that it was thought best to carry through another experiment to test the correctness of the previous figures. In fact roller bran differs to such an extent from that with which German trials were probably made, that the single previous test by this Station is really the only one to which reference could heretofore be had that applies to such bran as the market now affords.

The gluten meal and bran were purchased in the Bangor market.

Analytical data.

COMPOSITION OF GLUTEN MEAL AND WHEAT BRAN.

	Air dry material.						In 100 parts water-free material.				
	Water.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
CXXXIV, Gluten Meal	10.20	1.00	30.81	.98	47.22	9.79	1.11	34.30	1.09	52.60	10.90
CXXXV, Wheat Bran.	11.73	6.00	15.50	9.66	52.01	5.10	6.79	17.56	10.94	58.93	5.78

COMPOSITION OF FECES FROM GLUTEN MEAL AND WHEAT BRAN.

	Fresh feces.		In 100 parts water-free substance.				
	Water.	Dry substance.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
Gluten Meal, Sheep 2	63.82	36.18	8.91	11.57	32.36	42.81	4.35
" " " 4	77.90	22.10	9.65	16.36	27.80	41.98	4.21
Wheat Bran, Sheep 1	62.89	37.11	10.65	9.15	29.94	45.98	4.28
" " " 3	70.42	29.58	11.72	8.46	29.11	47.27	3.44

FOOD EATEN AND FECES EXCRETED.

		Food eaten daily.		Feces excreted daily.	
		Air dry.	Water-free.	Fresh.	Water-free.
Sheep 2,	Timothy Hay	500	461.8	636.4	230.2
	Gluten Meal	300	269.4		
Sheep 4,	Timothy Hay	500	413.5	884.	195.4
	Gluten Meal	300	269.4		
Sheep 1,	Timothy Hay	500	461.8	756.4	280.7
	Wheat Bran	300	264.8		
Sheep 3,	" "	"	"	1046.8	309.6

DIGESTION COEFFICIENTS FOR GLUTEN MEAL AND WHEAT BRAN.

	Dry substance.	Organic matter.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
Gluten Meal, Sheep 2	84.7	86.3	......	90.2	......	88.2	85.6
" " " 4	90.2	91.9	......	83.	33.4	93.5	90.1
Average	87.4	89.1	......	86.6	......	90.8	87.8
Wheat Bran, Sheep 1	65.3	68.5	......	82.7	46.9	69.6	59.5
" " " 3	54.4	59.5	......	81.5	25.5	58.6	68.6
Average	59.8	64.	......	82.1	36.2	64.1	64.
Results of previous trial*	58.8	62.8	......	73.7	......	67.5	82.6

* See Rep. Me. Exp. Station, 1889, p. 61.

SUMMARY OF DIGESTION COEFFICIENTS.

	Dry substance.	Organic matter.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extract.	Fat.
Hungarian Grass	63.4	65.6	35.5	62.4	67.8	65.8	52.3
Hungarian Hay	65.	66.3	47.4	60.	67.6	67.1	63.8
So. Corn Fodder	69.4	70.6	57.4	65.4	74.2	69.5	70.9
Field Corn Fodder	70.6	72.4	52.9	61.8	75.6	72.6	70.2
Sweet Corn Fodder	69.7	73.5	39.4	61.8	76.7	72.1	76.4
Timothy Hay	58.5	60.1	29.6	44.1	56.4	63.6	74.3
Timothy Hay	59.1	60.2	39.7	47.5	54.8	64.7	69.8
Sugar Beets	94.5	98.7	31.9	91.3	100.7	99.9	49.9
Mangolds	78.5	84.8	16.4	74.7	42.8	91.3	......
Rutabagas	87.2	91.1	31.2	80.3	74.2	94.7	84.2
Eng. Flat Turnips	92.8	96.1	58.6	89.7	103.	96.5	97.5
Gluten Meal	87.4	89.1	......	86.6	......	90.8	87.8
Wheat Bran	59.8	64.	......	82.1	36.2	64.1	64.

(1) The Hungarian Grass, both when fed green and after drying, proved to be more digestible than the average of other grasses—notably more so than Timothy.

(2.) The drying of the Hungarian Grass into hay did not diminish its digestibility. This is in accordance with all former experience.

(3.) The corn plant as cut for the silo is one of the most digestible of fodder plants, rating in these experiments as compared with Timothy as 100 : 120. Sixty per cent. of the dry organic matter of Timothy was digested, while with the various corn fodders the average was seventy-two per cent.

The experiments of this year disclose no especial differences in the digestibility of the Southern, Field and Sweet Corn fodders.

(4.) The digestion trials with roots show them to be the most digestible of any of the foods tested, the amount of waste material being very small, averaging not over 8 per cent. of the whole.

(5.) The Gluten Meal, which is a waste product in the manufacture of glucose from corn, was digested to the extent of 89 per cent. of its dry organic matter, which does not differ at all from the figures given in the German tables for the entire grain. The treatment which the grain receives in converting the starch into glucose does not seem to affect the digestibility of the refuse.

(6.) The second trial of the digestibility of American wheat bran gives average figures almost similar to those obtained in the first trial, and shows this cattle food to be but slightly if any more digestible than good hay and much inferior in this respect to grains such as maize, oats, barley, etc.

THE PRODUCTION OF FOOD MATERIAL BY VARIOUS FODDER AND ROOT CROPS.

The list of cattle foods which many successful dairymen seem to regard as necessary for winter production of milk includes some green material. This material is furnished either from the silo or by some one of the various root crops, undoubtedly more largely from the former than from the latter at the present time. Ensilage is made almost wholly, at least in this State, from the corn plant, and in regard to the most desirable variety of corn for this purpose there seems to exist quite a difference of opinion. The roots most generally grown for winter feeding are mangolds, sugar beets, rutabagas and English field turnips. The inquiry of the farmer is, which of these crops is the most profitable? "Shall I produce the large varieties of Dent corn, such as the Virginia White Horse Tooth, or shall I depend upon the varieties of Flint corn and Sweet corn which make much smaller growth, but which come more nearly to maturity in this climate? Or is it better to adhere to the former practice and produce sufficient roots of some kind to furnish the needed change of food?" In attempting to study this question, in order to give the farmer helpful information, we must first decide what is the proper standard for judging the profitableness of a crop. Two factors must be considered, (1) the amount of food material produced and (2) its cost. With the latter factor the Experiment Station does not propose to deal in this connection. In regard to the former factor, we must ask, How shall we judge with regard to the production of food material? It is very evident that we cannot take as our standard the total weight of the crop, for the reason that there is so large variation of the amount of water in the various crops which have been mentioned. This water is worth no more than that which the animal takes from the trough. But shall we use the total dry matter as a measure of profitable production, excluding the question of cost? This would certainly be more accurate than to judge from the total weight of the crop, but it is evident that there would still be an inaccuracy from the fact that the dry matter of the various fodder plants varies greatly in digestibility. We must conclude then that the proper standard by means of which to compare the production of food material by various crops *is the amount of digestible dry material.* One other factor enters which it is necessary to consider to some extent, and that is the relative value of equal amounts of digestible material from different crops. For instance, the large varieties of Dent corn do not mature in this climate, but must usually be cut and put in the silo before the formation of the ear, while with our early varieties of field and sweet corn, the plant can generally be fully matured. The question arises, Is a pound of digestible material in the immature large variety equal in value to a pound of digestible material from the smaller and maturer sort?

The Maine Experiment Station has addressed itself to the study of the problems suggested above. Work in this direction was begun in the summer of 1888 and has been continued through three seasons.

In 1889 the experiment was confined to three varieties of the corn plant (see Rep. Me. Exp't Station 1889, p. 46), but in 1890 and 1891 root crops and other varieties of fodder crops were included.

The general plan followed has been to select soil uniform in quality and in previous treatment, producing upon it equal areas of the several crops under like conditions of manuring, cultivation, etc. A record has been made of the weight of each crop, and its composition, and in part its digestibility, have been determined. The following is a description of the soil and of the method of manuring, planting and cultivation for the several seasons:

1888.—Soil, clayey loam. Land in grass for several years previous. Sod broken in spring, and 600 lbs. superphosphate drilled in with seed. Seed drilled in with Eclipse corn planter. Three varieties of corn were planted on two acres. This area was divided into twelve plots, four plots being used for each variety.

1890.—Soil, clayey loam. In cultivation for four previous years. About seven cords per acre of good manure from barn cellar applied the previous autumn. Seed planted by hand. Size of plots one-twentieth of an acre, two plots being devoted to each variety of crop. The corn and root crops were thinned during cultivation to a uniform distance of plants.

1891.—Soil, clayey loam. Land in grass since 1885. Sod broken in spring and about six cords of manure from cow stable applied per acre. 240 lbs. per acre of a fertilizer consisting of 100 lbs. dissolved bone black, 100 lbs. nitrate of soda and 40 lbs. muriate of potash were sowed in the drill before the seed was planted. Manner of seeding and cultivation the same as in 1890.

The varieties of corn, roots, etc., which have been grown are the following:

Southern Corn,—White Horse Tooth.
Field Corn,—a Flint variety maturing in Penobscot Co.
Sweet Corn,—Early Crosby.
Sugar Beets,—Lane's Imperial.
Mangolds,—Champion Yellow Globe.
Rutabagas,—Yellow Globe.
English Flat Turnip,—Purple Top Strap Leaf.
Peas,—Black Eyed Marrowfat.
Hungarian Grass.

The Hungarian grass was not grown on the same land as the other crops, but the yield of this fodder plant was determined by weighing the produce from a crop fed to the College herd.

In 1888 the corn was planted with a seed drill as before stated, and when hoed the first time it was thinned as nearly as possible to two stalks per foot. About the same number of stalks were grown with each variety. In both 1890 and 1891 two stalks were grown to a foot with the Southern Corn and one stalk to a foot with the Common Field Corn and Sweet Corn. This degree of thickness with the several varieties was adopted because of the results of an investigation made by the Connecticut Experiment Station in the summer of 1888. (See Report of Conn. Exp't Station, 1889, Part 1, pages 9 to 43.) This investigation showed that the maximum amount of dry matter was produced when the variety of Dent corn used was grown with two stalks to the foot and the Flint variety with one stalk to the foot. Of course the conditions of growth are different in Connecticut from what they are in Maine, and it is possible that a similar investigation made at this Station would show that a different thickness of planting should be adopted in order to obtain maximum production. No better guide is at hand, however, than the outcome of the experiment mentioned.

In the case of the root crops the plants were thinned to the distance of one foot in a row in all of the three seasons. The peas were sown in drills at the rate of two bushels of seed per acre. With all of the crops the distance between the rows has been three feet.

The three varieties of corn were cut and weighed at the time the kernels of common field corn had become glazed and the sweet corn was past the canning stage. No ears had formed on the Southern corn. The roots were left in the ground as long as possible.

PRODUCTION BY SEVERAL VARIETIES OF FODDER AND ROOT CROPS.

		Total crop as harvested, per acre.	Per cent. dry matter in grain crop.	Yield of dry matter per acre.	Per cent. of dry matter digestible.	Yield of digestible dry matter per acre.
		lbs.	%	lbs.	%	lbs.
Southern Corn,	1888	26.295	12.30	3234.8	65.	2102.8
	1890	32,950	14.94	4922.7	69.	3396.7
	1891	46,340	13.46	6237.4	69.*	4303.8
	Average for all	35.195	13.57	4798.1	......	3267.4
	Average for 1890 & 1891.	39 645	......	5580.	......	3850.
Field Corn. (Flint)	1888	14.212	17.4	2472.9	70.	1720.5
	1890	15,300	15.84	2415.9	71.	1715.3
	1891	28,080	13.55	3804.8	71.*	2701.4
	Average for all	19.197	15.60	2892.8	......	2045.7
	Average for 1890 & 1891	21,690	......	3110.	......	2208.
Sweet Corn	1888	14,205	13.5	1917.6	61.	1169.7
	1890	13,300	16.15	2147.9	70.	1503.5
	1891	23,220	13.76	3195.0	70.*	2236.5
	Average for all	16,908	14.47	2420.1	......	1636.5
	Average for 1890 & 1891	18,260	......	2671.	......	1870.
Mangolds	1890	18,400	11.73	2158.3	78.5	1694.3
	1891	12,350	8.65	1068.	78.5*	838.4
	Average	15,375	10.19	1613.1	......	1266.
Sugar Beets	1890	14.350	16.25	2331.9	94.5	2203.6
	1891	20,940	13.60	2847.8	94.5*	2691.2
	Average	17.645	14.92	2589.9	......	2447.4
Rutabagas	1890	31,550	10.95	3454.7	87.2	3012.5
	1891	31,840	10.60	3375.	87.2*	2943.0
	Average	31,695	10.77	3414.8	......	2977.7
Eng. Flat Turnips	1890	32.350	9.76	3157.4	92.8	2930.
	1891	24.650	7.96	1962.1	92.8*	1820.7
	Average	28.500	8.86	2559.7	......	2375.
Hungarian Grass,	1890	18,940	24.71	4680.	63.4	2967.
Peas, (total crop)	1890	3.522	......	....	......	....
	1891	5,329	......	....	......	....
	Average	4,425.5	......	....	......	....
Peas, (grain)	1890	1,850	85.00	1572.	87.	1367.6
	1891	1,481	......	1258.8	87.	1095.1
	Average	1,665.5	......	1415.4	......	1231.3
Timothy Hay (assumed crop)		4.000	87.50	3500.0	......	....

* Assumed to have the same digestibility as crops of previous year.

SUMMARY OF AVERAGE RESULTS FOR 1890 AND 1891.

	Yield per acre of crop as harvested.	Yield per acre of dry matter.	Yield per acre of digestible dry matter.
	lbs.	lbs.	lbs.
Southern Corn	39.645	5580	3850
Rutabagas	31,695	3415	2978
Hungarian Grass	18.940	4680	2967
Sugar Beets	17.645	2590	2447
English Flat Turnips	28.500	2559	2375
Field Corn (Flint)	21.690	3110	2208
Sweet Corn	18,260	2671	1870
Mangolds	15,375	1613	1266
Peas (Grain)	1,665	1415	1231
Timothy Hay (assumed crop)	4.000	3500	2065

In discussing the above figures which are a statement of the yield of the several crops under consideration, it should be remembered that no effort was made to secure phenomenally large production. It is not claimed that in any case a maximum crop was harvested, although the growth in 1891 of twenty-three tons of So. Corn and fourteen tons of Field Corn per acre, is a fairly creditable showing. The sole purpose of these experiments has been to test the *relative* growth of these fodder and root plants, under conditions as entirely similar as it was possible to make them.

The results here given are not considered as final. Plans are in progress for repeating this work in other sections of the State on typical corn land, under conditions unquestionably favorable to a solution of the problem involved. Notwithstanding the fact that this should be considered as a report of progress, it may not be out of place to summarize the results so far reached. It should be borne in mind in this connection, that the question of cost is entirely ignored.

(1.) The large variety of fodder corn, namely: the Southern White Horse Tooth, under the conditions in which the crops were grown greatly excelled the other varieties of corn and the roots in the production of total and of digestible dry matter.

(2.) The crops which rank next in the production of digestible dry matter are Hungarian grass and rutabaga turnips.

Special attention is called to the very favorable comparative showing of Hungarian Grass as a fodder producing crop.

(3.) The common impression seems to be that our varieties of field corn and sweet corn which mature in this latitude and which are harvested for the silo after the plants have reached maturity or nearly so, contain much less water and more dry matter than the larger varieties of Southern corn. While these experiments show a difference in the percentage of dry matter in favor of the Field Corn and Sweet Corn, the difference has not proved to be as great as many would expect. The average results for three years show that the Northern field corn contained only two pounds of dry matter per hundred more than the Southern corn at the time the crops were harvested.

(4.) These experiments illustrate very fully the already familiar fact that the weight of a green fodder crop is not a correct standard for judging its value. For instance, 18,940 pounds of Hungarian grass contained more than a third more dry matter than 31,695 pounds of rutabaga turnips, and practically as much dry matter as 32,000 pounds of Southern corn.

TURNIPS AS FOOD FOR SHEEP.

The relative value of different cattle foods is a matter which is very much discussed by farmers. Perhaps no foods have received, more attention during the last few years than have those which are fed in a green condition such as ensilage and roots. The Experiment Station receives very many inquiries in regard to their value as compared with hay and the various grains.

Whenever these inquiries have been answered by the writer, the amount of digestible organic matter has been taken as a basis for comparison. For instance, a food containing 60 per cent. of digestible organic matter has been regarded as having five times the capacity for nourishing an animal that one has containing twelve per cent., especially if the two foods are not greatly unlike in the composition of their dry matter. Experiments made by this Station go to show that the digestible matter present in food is a fairly safe standard for measuring its value. A feeding experiment which was made in the winter and spring of 1889, the purpose of which was to compare ensilage and hay, gave results which seemed to warrant the following as part of the conclusions reached. "The experiment furnished still further evidence that the amount of digestible matter present may be regarded as a safe basis for comparing the feeding value of foods of the same class." (Report Maine Experiment Station, 1889, page 75.) The comparison referred to above was made by feeding young steers. In the previous spring of 1888, a similar comparison was made, using milch cows as the experimental animals. This test showed unmistakably that a pound of digestible material coming from a mixture of hay and ensilage gave better results than a pound coming from hay alone, but the difference was not great. In summarizing this latter experiment the following statement was made: "Nevertheless, the testimony of such results as this experiment furnished sustains rather than destroys the general practical utility of the rule in making rations, that fodders have a relative value that is proportionate to their digestible material." (Report Maine Experiment Station, 1889, page 69.)

The results of a few feeding trials like these do not seem to be considered by many to be a sufficient guide for directing their practice in cattle feeding. Experience and observation have appeared to show that roots have a value which scientific investigation does not accord to them and many feeders are very slow to look any farther than commonly expressed opinion. The opinion is met in many quarters that roots are especially profitable as food for sheep. Hon. I. C. Libby of Burnham, Me., in a conversation with a member of the Station staff, advanced the idea that turnips have a value as sheep food greater than that with which they are generally credited, and greater, perhaps, than they have as food for certain other classes of animals. Later, in a letter addressed to the Director of the Station in response to certain inquiries, Mr. Libby referred to the importance of sheep husbandry to Maine, and expressed the opinion that roots should be made to fill a more prominent place in the sheep ration. He also suggested that the relative value of roots would be a proper subject of investigation by the Station. In accordance with this suggestion, plans were made for conducting an experiment with sheep in the winter of 1890-91, which should have for its sole object a comparison of the value of roots and of mixed grains as fattening food. During the summer of 1890, the requisite quantity of Rutabagas was produced on the College Farm, which were stored in fine condition. Early in December twenty-four good sized and perfectly healthy ewes were purchased. They were somewhat thin in flesh and were in first-rate condition for use in an experiment of this kind.

In planning this experiment it was possible to do so from either of two points of view. It is very commonly remarked when roots are made a subject of discussion, that they are especially valuable because by feeding them the animal is kept in a more healthy condition and his appetite is stimulated, so that more of other kinds of food are consumed and therefore greater growth is obtained than would otherwise be possible. This is one point of view. The other is a consideration of roots as a main supply of food outside the coarse fodder, or as a substitute for grain. Now if an experiment were to be planned to test the value of turnips because of their physiological effect in the ration, the question would be answered only by feeding one lot of sheep on dry food entirely and another lot on dry food combined with more or less roots. But if the nutritive effect of turnips as a main supplement of hay is the point to be considered, then a safe conclusion can more surely be reached by feeding some turnips to one lot of sheep and more to the other, the difference in amount of digestible material in the two cases to be made up by a larger amount of grain. In this way both lots of sheep would receive the beneficial effect upon health and appetite which green food is supposed to give, and we would be studying the single question of the relative value of roots and grain. Consequently the ration of the two lots of sheep were planned as nearly as possible so that each lot received the same amount of digestible material, the difference being that more of this material came from grain in the one case and more from turnips in the other. The feeding of the sheep was begun on December 23. The rations were as follows:

Lot 1,	20 lbs. Hay, mostly Timothy. 12 lbs. Mixed Grain. 20 lbs. Cut Rutabagas.
Lot 2,	20 lbs. Hay. 7 lbs. Mixed Grain. 50 lbs. Rutabagas.

The mixed grain consisted of three parts gluten meal, two parts corn meal and one part wheat bran, by weight. This feeding period was continued until Jan. 30. It is seen that in this period Lot 1 ate five pounds more of the mixed grain each day than Lot 2, and that Lot 2 ate 30 pounds more of turnips daily than Lot 1, or in other words, five pounds of mixed grain were against 30 pounds of turnips, it being calculated that the amount of digestible material would be about the same in the two. The animals were weighed first on December 29th and 30th, and again on Jan. 29th, and 30th. The following table shows the amount of food eaten and the gain of each lot of sheep.

FOOD AND GAIN OF SHEEP IN PERIOD 1.

	Lot 1. More grain.	Lot 2. More Turnips.
No. of days fed	31	31
Weight of hay fed	620 lbs.	620 lbs.
Weight of mixed grain eaten	372 “	217 “
Weight of rutabágas eaten	620 “	1550 “
Weight of sheep at end of period	1222 “	1124 “
Weight of sheep at beginning of period	1125 “	1052 “
Gain in weight	97 lbs.	72 lbs.

It appears by the above that Lot 1, receiving the more grain, gained 97 pounds, and Lot 2, receiving the more turnips, gained 71 pounds, a difference of 25 pounds. It is fair to conclude, then, that the five pounds of grain produced more increase in weight than the

30 pounds of turnips. How about the amount of digestible material in each case? At the time the experiment was begun, the amount of dry matter in the turnips was not actually known, but was assumed from previous analyses. During the time of the first feeding period the percentage of dry matter actually present in the turnips that were being fed was ascertained and it was found that the five pounds of mixed grain contained about four-tenths of a pound more of digestible material than the 30 pounds of turnips. The ration for the second period of feeding, beginning on Jan. 30, was changed therefore somewhat from that of the first period. The changed rations were as follows:

Lot 1,	20 lbs. Hay. 9 lbs. Mixed Grain. 50 lbs. Rutabagas.
Lot 2,	20 lbs. Hay. 13 lbs. Mixed Grain. 20 lbs. Rutabagas.

In this period 30 pounds of turnips were offset by only 4 pounds of grain. Lot 1 was fed the larger amount of turnips instead of Lot 2 as in Period 1. The feeding was continued until March 3, the animals being again weighed on each of the last two days.

Below can be seen the weight of the two lots and the amount of gain of each during the second period.

FOOD AND GAIN OF SHEEP IN PERIOD 2.

	Lot 1. More Turnips.	Lot 2. More Grain.
No. of days fed	32	32
Weight of hay fed	640 lbs.	640 lbs.
Weight of mixed grain eaten	288 "	416 "
Weight of rutabagas eaten	1600 "	640 "
Weight of sheep at end of period	1346 lbs.	1262 lbs.
Weight of sheep at beginning of period	1222 "	1124 "
Gain in weight	124 lbs.	138 lbs.

Gain of both lots of sheep eating more turnips	235 lbs.
" " " " " " grain	196 "
Difference in favor of ration containing more grain	39 lbs.

The results of the second feeding period still show an advantage with the sheep eating the more grain as compared with the sheep eating the more roots, although rather more digestible material was fed to the latter lot.

AMOUNT OF DIGESTIBLE MATERIAL* IN 100 LBS. OF FOODS EATEN.

	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Timothy hay	2.95	15.75	28.09	2 69
Rutabagas**	1.23	.90	8.30	.50
Gluten meal	26.67	.....	42.97	8.61
Corn meal	8.16	......	64.30	4.33
Wheat bran	12.76	3.50	33.28	3.26

POUNDS OF DIGESTIBLE MATERIAL EATEN IN 63 DAYS.

	Protein.	Fiber.	Nitrogen-free extract.	Fat.
	Larger grain ration for 12 sheep.			
Timothy hay, 1260 lbs	37.2	198.4	353 9	33.9
Rutabagas, 1260 lbs	15.5	11.3	104.6	6.3
Mixed grain, 788 lbs	143 3	4.7	381.9	49.5
Nutritive ratio, 1:6.5	196.0	214.4	840.4	89.7
	Larger turnip ration for 12 sheep.			
Timothy hay, 1260 lbs	37.2	198.4	353.9	33 9
Rutabagas, 3150 lbs	38.7	28.3	261.4	15.8
Mixed grain, 505 lbs	91.8	3.	244 7	31.7
Nutritive ratio, 1:7.7	167.7	229.7	860.0	81.4

The results of the entire experiment, covering 63 days of feeding, may be summarized as follows:

One-half of the sheep ate during this time 1340 pounds of digestible material and the other half ate 1338 pounds. The difference between the two rations was simply this: that one-half of the sheep received more of their food from roots than did the other half, the total amount of digestible material being practically the same in the two cases. One-half of the sheep ate 1260 pounds of roots and the other half ate 3150, the difference in the amount of dry digestible organic material

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* The figures in this table are obtained from the composition and digestibility of Timothy hays Nos. CXL and CXLI, gluten meal CXXXIV, and wheat bran CXXXV, as found on previous pages of this report. The hay was estimated to have 12.5% of water as fed in the barn. For the corn meal the figures of the general fodder tables were used.

** These turnips contained—water 87.19%, solids 12.81%, protein 1.54%, fiber 1.21%, N-f-ext. 8.74%, fat .59%.

in the two quantities being 206 pounds. This 206 pounds of nutrients from the roots was offset by 208 pounds of nutrients from grain, a practically eduivalent quantity. Notwithstanding this equivalence in the quantity of material in the two rations, the twelve sheep receiving the more grain gained during the 63 days 39 pounds more than did the other twelve. There seems to be no reason why this test is not a fair one and it furnishes a weighty bit of evidence against the somewhat common opinion that the dry matter of roots has an especial and peculiar value beyond the small quantity which it may be wise to feed for the purpose of giving variety to the ration.

There still remains to be considered the reason why the two rations produced unlike results, even though they contained equivalent quantities of digestible material. We find by examination of the figures last given that one ration furnished to the animals considerable more digestible protein (nitrogenous compounds) than did the other, and this fact seems to be the most reasonable explanation of the difference in effect. The more nitrogenous ration produced more increase in weight. This was the ration having more grain and less rutabagas. This result is not surprising when we remember that the food of a pregnant ewe must supply material for the growth of the wool and of the fœtus, and that in both these directions the demand is very largely for protein compounds.

AN EXPERIMENT IN PRODUCING GROWTH IN LAMBS.

The object of this experiment was to present an object lesson on the profits of the liberal feeding of lambs that are intended for the market. A farmer is occasionally found who has adopted the practice of producing early lambs, which by liberal feeding can be put upon an early market at high prices. The more common practice is the production of late lambs which are grown largely on grass and are sold at the lowest prices that rule during the year. It was thought that possibly an illustration of the difference between these two methods might serve to stimulate some towards adopting the former and more profitable practice. It was found that the 24 ewes used in the feeding experiment with roots just described, were likely to drop their lambs during the month of April. As they were a lot of sheep quite uniform in quality, of more than average size and in good condition, because of the liberal rations which they had received, it was decided to use their lambs for this experiment. Accordingly, as fast as the lambs were born, they were divided into two lots. Fortunately there were an even number of pairs of twins, so that when the division into the two lots was completed, it was found that there were ten sheep with twelve lambs in each pen.

These two lots of sheep and lambs were fed in a radically different manner. The ration of Lot 1 was intended to be an intensive ration, or a copy of the method that is used for forcing the growth of early lambs. On the other hand, Lot 2 was fed in a manner similar to that which is adopted by many farmers, who consider the sheep to be an animal that can be successfully fed on the refuse of a barn without the addition of very much grain. The sheep of Lot 1 received what good hay they would consume and a pound of grain each, per day. Besides this, the pen was so arranged that the lambs had access at all times to a supply of mixed grain. The sheep of Lot 2 were fed one-half pound grain per head daily. with what good hay they would eat. The lambs of this lot were allowed no grain excepting what they ate from the mother's ration. Until May 26th, the grain mixture consisted of three parts of gluten meal, two parts of corn meal and one part of wheat bran, by weight. After May 26th, the mixture was changed to one part of linseed meal, one part of corn meal and one part of wheat bran, by weight. Lot 1 ate 2,990 pounds of hay and 900 pounds of mixed grain. Lot 2 ate 3,010 pounds of hay and 450 pounds of mixed grain. The weight of grain eaten by the lambs of Lot 1 was 534 pounds. Besides this, both lots of sheep received two pounds per day, per head, of rutabaga turnips, until May 19th.

The following table gives the figures in detail for each sheep and lamb of both lots:

RESULTS OF EXPERIMENT IN FEEDING LAMBS.

Lot 1, Liberal feeding.

Date of birth of lambs.	Weight of sheep after birth of lambs.	Weight of lambs at birth.	Weight of fleece of sheep.	Weight of sheep when lamb 3 months old.	Weight of lambs at 3 months.
	lbs.	lbs.	lbs.	lbs.	lbs.
March 21..........	97	12	5	76	51
" 28..........	103	8 8 Twins.	6	90	40 45
April 4.............	108	12	5¼	89	65
" 5.............	94	9	7	85	44
" 10.............	110	11	6¾	87	51
" 14.............	100	9 9 Twins.	8	67	38 38
" 15.............	95	9	5½	77	45
" 17.............	68	9	5	60	43
" 21.............	90	8½	5¾	80	40
" 23.............	102	10	4½	93	45
Total weights....	967	122	58¾	804	545

Lot 2, very moderate feeding.

March 21...........	90	10	6	71	49
" 29	90	8 8 Twins.	4¾	67	20 20
April 2.............	107	12	5½	91	34
" 4.............	102	10	6	94	37
" 6.............	119	14	7	95	38
" 13.............	80	10	6½	70	30
" 17.............	98	8	6½	79	38
" 18..........	96	11	6	75	32
" 21.............	93	9	7	50	24
" 23.	109	9 9 Twins.	5	76	20 22
Total weights....	984	126	60¼	768	364

SUMMARY OF RESULTS.

	Lot 1. Liberal Ration.	Lot 2. Moderate Ration.
	lbs.	lbs.
Total hay fed in 3 months	2990	3010
Total grain eaten by sheep in 3 months	900	450
Total grain eaten by lambs in 3 months	534	......
Weight of sheep after birth of lambs	967	984
Weight of fleeces taken off	59	60
Weight of sheep when lambs 3 months old	804	768
Loss in weight of sheep after deducting fleece	104	156
Weight of lambs at birth	122	126
Weight of lambs at age of 3 months	545	364
Weight of growth in 3 months	423	238
Average weight of lambs at birth	10.2	10.5
Average weight of lambs at 3 months	45.4	30.3
Largest w't of lambs from any single sheep in 3 mos.	95	49
Largest weight of any single lamb in 3 months	65	49

The second table summarizes the figures of the first. The results of this experiment are quite striking and would have been more so had the sheep been the very best quality of Shropshire grades, for instance. As it is, the object sought of illustrating the profits of high feeding of early lambs is attained. It seems that each lot of sheep lost between one and two hundred pounds in weight during the time the lambs were with them, after deducting the weights of the fleeces, Lot 2 losing 52 pounds more than Lot 1. The twelve lambs of Lot 1 weighed, at the end of three months, 545 pounds, and of Lot 2, 364 pounds, a difference of 181 pounds. As the weights of the lambs when born was, for Lots 1 and 2, 122 and 126 pounds, respectively, the actual growth made after birth was 423 pounds and 238 pounds, or a difference of 185 pounds. Now, to offset this greater loss of weight of 52 pounds on the part of the sheep and greater growth of lambs of 185 pounds, we have the cost of 984 pounds of mixed grain, this being the extra amount which was eaten by the sheep and lambs of Lot 1. We must also take into account the fact that the lambs of Lot 1 were ready for the market during the month of May, when high prices were ruling, while the lambs of Lot 2 must be grown for some time longer in the pasture and be put upon the market at very much lower prices.

A statement of the financial results of an experiment is always a difficult matter. Whatever may be the prices taken to represent the values of any product, these will be found to differ from the prices which some producers are able to obtain. The best that can be done is to assume as nearly as can be determined, the average market rates according to past experience. In the present instance the case is like this: Two lots of lambs have been grown, one lot being large enough and fat enough to put upon an early market, the other lot being too small and too lean, thus requiring that they should be sent to pasture and sold on a late market. This condition of things corresponds to what may be observed in much of the practice of the State.

Lambs that are dropped in March and which are intended for the market may, by a system of high feeding, be sold at a price which is equal to at least ten cents per pound, live weight. If, however, the kind of feeding is such as still prevails to a very great extent, the lambs will of necessity go to pasture with their mothers and will be sold at a price not exceeding six cents per pound, live weight. Let us, then, apply these prices of ten cents and six cents to the lambs grown in this experiment.*

FINANCIAL RESULTS.

545 lbs. lamb @ 10 cts	$54 50
364 " " @ 6 cts	21 84
Difference in value of lambs	$32 66
Value of 52 lbs. sheep @ 5 cts	2 60
Increased value from liberal feeding	$35 26
Value of 984 lbs. extra grain @ $26	12 79
Net gain from liberal feeding	$22 47
Return per ton for extra grain fed	$71 60

It appears from the above figures that the lot of sheep and lambs which were liberally fed were worth at the end of three months $35.26 more than the other lot. After deducting from this sum the cost of the 984 pounds of grain which were fed over and above that given to Lot 2, we have $22.47 as the net gain which should be credited to liberal feeding.

It seems, therefore, that the extra grain was sold to the sheep at the rate of $71.60 per ton.

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* After the above was written the following note was received from Chas. York, Esq., a dealer in groceries and provisions, Bangor: "I find by referring to our books for the past five years that the average price of lambs during May has been 19 cts. per pound, for June 16 cts., and for Aug. and Sept. 8 to 10 cts." This illustrates the condition of the local market merely.

SUMMARY.

(1.) Two lots of sheep, each containing ten sheep and twelve lambs, were fed for three months.

(2.) One lot of sheep ate 3,000 pounds of hay and 1,434 of mixed grain. The other lot ate 3,000 pounds hay and 450 pounds of mixed grain. Lot 1 ate, therefore, 984 pounds more of grain than Lot 2.

(3.) During the three months the sheep of Lot 1 lost 104 pounds in weight, and Lot 2, 156 pounds, a difference in favor of Lot 1, of 52 pounds. The lambs of Lot 1 weighed 545 pounds, and of Lot 2, 364 pounds, a difference in favor of Lot 1 of 181 pounds.

(4.) The value of the lambs in Lot 1 was $54.50, and in Lot 2, $21.84, a difference of $32.66 in favor of liberal feeding, and a net gain above extra cost of grain of $22.47.

(5.) The extra amount of grain fed to Lot 1 was sold to the sheep at the rate of $71.60 per ton.

FEEDING EXPERIMENT WITH COLTS.

An investigation of the relative value of different feeding stuffs as food for colts, involves two main considerations:

(1.) The amount of growth produced.

(2.) The quality of the animal.

A horse is said to have good quality when he has a well developed muscular system and exhibits that nervous activity or force which we call life or spirit. Apart from inherited tendencies, the development of *quality* depends, we may believe, partly upon the kind and quantity of food and partly upon the way the animal is handled, i. e., the exercise and training.

It would be a very difficult task to carry out experiments or investigations that would establish the relation between food and quality. It would be necessary to use more than a few animals, which should be of identical breeding, and which should be fed for several years on the rations to be compared. The writer is not aware that up to the present time such an experiment has been attempted. There exists, however, a very wide spread opinion that oats are superior to any other horse food for giving that muscular and nervous condition which so largely determines the market value of an animal.

A test of the amount of growth produced with colts by various foods is not especially difficult, at least not more so than with bovines. Two such tests have been made by this Station, one in 1890, (see Station Rep't, 1890, p. 68) and one in 1891, the results of which follow. In both instances oats have been compared with a mixture of other grain foods, such as peas and wheat middlings (1890), and gluten meal, linseed meal and middlings (1891).

The outcome of the experiment in 1890 was that oats produced less growth than an equal weight of a mixture of peas and middlings, the relation of growth being as 100 to 111. The fact that in this experiment peas were used as a part of the grain ration, a food that in the market is comparatively costly, seemed to be a good reason for repeating the experiment with commercial foods that are more common, bear a less price and are comparatively nitrogenous in character.

In this second experiment, which was made in the spring of 1891, two colts were used. No. 1 was a grade Percheron filly eleven months old, and No. 2 was a grade Percheron gelding eleven months old.

They were fed through two periods on the following rations:

Period 1,	Colt 1,	10 lbs. hay. 6 lbs. grain mixture.
	Colt 2,	10 lbs. hay. 5 lbs. grain mixture.
Period 2,	Colt 1,	10 lbs. hay. 7 lbs. oats.
	Colt 2,	10 lbs. hay. 6 lbs. oats.

The grain mixture consisted of middlings, gluten meal and linseed meal compounded in the ratio of 60, 35 and 15. The average daily cost of the ration in Period 1 was about 12 cents, and in Period 2 about 14 cents, a difference of two cents per day for each animal.

The feeding began on March 12th, and the animals were first weighed on March 17th and 18th. Period 1 continued 43 days, and Period 2, 41 days.

The colts were tied in stalls and were given free exercise in a large yard during all pleasant weather. So far as could be determined, no unfavorable conditions entered into the experiment.

The results are stated below:

	Colt No. 1.	Colt No. 2.
Weight of colts at end of Period 1	776 lbs.	652 lbs.
Weight of colts at beginning of Period 1	711 "	602 "
Gain in weight in 43 days	65 lbs.	50 lbs.
Daily gain on mixed grains	1.51 lbs.	1.16 lbs.
Weight of colts at end of Period 2	794 lbs.	690 lbs.
Weight of colts at beginning of Period 2	776 "	652 "
Gain in weight in 41 days	18 lbs.	38 lbs.
Daily gain on oats	.43 lbs.	.93 lbs.

A glance at the above data is sufficient to show the more rapid growth on the mixed grain ration. Those who carefully consider these figures may be inclined to remark that the difference in growth caused by the two rations is too great and that some disturbing factor must have entered, thus rendering the results invalid. Certainly nothing of the kind was apparent, as before remarked.

In two tests of the relative growth produced in colts by mixed grains and oats, the greater growth was obtained in both instances from the mixed grains.

Let us return to the question of the relation of food to quality. As stated above, there seems to be a widespread opinion that oats are a superior food for horses. During the past few years the claim has been quite generally made, at least in popular literature, that this opinion has been strengthened by the supposed discovery through scientific research of the so-called *avenin*, a compound existing in the oat kernel, and said to possess properties that render it peculiarly stimulating to the nervous system. The existence of such a compound has been accepted as an easy way of explaining the peculiar effect which oats are said to have upon the spirit of a horse and in the development of the wiry, nervous Scotchman, who is addicted to his oat meal.

Has science, as in so many other instances, corroborated a belief reached through common experience? A careful study of the records relating to this question will help us to answer.

It seems that Norton, working in Johnston's laboratory, somewhere in 1845, separated what he evidently regarded as an albuminoid peculiar to the oat grain and it was named by Johnston, avenine. In 1869 Kreusler made an extended study of some of the nitrogenous compounds found in the oat kernel and his work appears to show that Johnston's avenine was very similar to legumine, and he accordingly named it oat legumine. Later, Osborne of the Connecticut Experiment Station, has made a very elaborate study of the various proteids separated from the oat grain by a number of solvents. The methods used by Osborne, owing to an advance in knowledge, were superior to those adopted by previous investigators, but did not tend to confirm the conclusions of either Norton or Kreusler. It appears to be true that notwithstanding the fact that the proteids of the oat grain have been made the subject of several very careful and elaborate investigations, using the best methods available, we have not yet any conclusive evidence that the oat kernel contains any characteristic nitrogenous compounds which may not be found in other grains. It is not difficult to see how the existence of this avenine as a substance peculiar to the oat plant has come to be accepted as a fact in popular literature, because when an error once obtains a foothold it is difficult to dislodge; but it is not so clear why this supposed compound should be credited with being a nerve stimulant. The writer is unable to find any investigation undertaken with a view to testing this matter; in fact is unable to find any data upon which such a conclusion could properly be based.

This seems to be an instance of that strange logic which so often appears in popular literature, namely: oats are a stimulating food; avenine exists in oats; therefore avenine is a stimulant. The writer is not prepared to deny that oats may have peculiar food properties that render them especially valuable as food for horses, but he believes that it should be distinctly understood that so far the only proof of this is a somewhat generally accepted opinion. It is safe to affirm also that this opinion is derived from common observation, rather than from any accurate investigations and it is just possible that it may share the fate of many other popular notions having a similar foundation. It is certainly to be considered that oats are a valuable food for horses if for no other reason because they can be fed very freely without danger of injury to health. Is it not possible that this food attained its present reputation at a time when corn was the particular food with which it was compared, and now that the markets afford such a variety of other foods equally nitrogenous or more so, can we be sure that oats are as essential as they once were to the development of a good piece of horse flesh?

The practical application of this discussion is this: Oats are a comparatively costly feeding stuff, and if they are not essential to the horse ration there would be a financial advantage in discarding their use so long as present prices hold.

THE INFLUENCE OF FOOD UPON THE QUALITY OF BUTTER.

There are many factors which determine the quality of butter, the most prominent of which is the individual character of the animal. Besides this we have the kind and condition of food, surroundings in which the animal is kept and the period of lactation. We know of the influence of these factors only in a general way. The exact relations between breed, food, surroundings and other conditions and the chemical and physical characteristics of butter are but little understood. Still more ignorant are we of the way in which certain causes produce their effects, as for instance, granting that the grade of butter may be changed by varying the food, we scarcely know anything about how this effect is produced. It is a fact that but few careful scientific investigations have been made having for their object a determination of the causes that influence the quality of butter. There has been, however, quite a material advance in recent years in our knowledge of the butter fats and in our methods of determining the physical and chemical properties of butter. This has been brought about to some extent by the study that has been necessary in finding some method of distinguishing between natural and artificial butters, and is an important step towards a better knowledge of the conditions that influence the character of butter.

The study which a butter is given in the laboratory, at the present time, involves principally the following determinations: The specific gravity, the melting point, the percentage of volatile acids and the iodine number or the amount of olein. There are other tests applied which are of less importance, perhaps. All these determinations are of value only in their relation to what we speak of as the table qualities of butter.

The influence of different foods upon butter is a subject in regard to which there are many conflicting opinions. For instance, it has been very strongly asserted by many Maine dairymen that no butter is of so high grade as that which is made when the grain ration consists of corn meal and wheat bran. On the other hand, those who are feeding the oil meals freely assert that the quality of the butter is not in any way injured. One difficulty that is in the way of an intelligent study of the effect of foods is our ignorance of the source of the butter fats. While the prevailing theory is, perhaps, that the butter fats are produced from the nitrogenous constituents of the food, there are still those who believe, and their opinions cannot be entirely gainsaid, that the fats of the food in some way directly contribute to the fats in the milk. If the fats of the food are conveyed directly into the butter, then we would expect to see a marked effect from the presence of either linseed meal or cotton seed meal in the ration, as these feeding stuffs carry a much higher percentage of fats than do others.

By the recommendation of the Station Council, this matter has been made the subject of an experiment, although similar ones have been conducted before. Five of the Station cows were fed three different kinds of rations during as many periods, the rations in the second period differing very materially from those in the first and third. An attempt was made to have this middle ration carry the smallest amount of vegetable fats that would be found in any combination of ordinary foods, while the first and third rations contained a fair proportion of cotton and linseed meal. The exact quantities and kinds of foods fed during the three periods are as follows:

Period 1—Cotton-seed meal, corn meal and wheat bran.

Period 2—Pea meal and barley meal.

Period 3—Linseed meal, corn meal and wheat bran.

KINDS AND QUANTITIES OF FOOD.

	Hay.	Cotton seed meal.	Linseed meal.	Corn meal.	Wheat bran.	Peas.	Barley.
1ST PERIOD.							
Jansje	23.9	2	......	4	2	......	......
Nancy	22.3	1¾	......	3½	1¾	......	......
Queen Linda	20.6	1¾	.....	3½	1¾	......	......
Agnes	20.6	1½	......	3	1½	......	......
Ida	20.2	1½	......	3	1½	......	......
2D PERIOD (Feb. 21 to Mar. 18).							
Jansje	24.	......	......	......	......	4	4
Nancy	22.7	......	......	......	......	3½	3½
Queen Linda	21.1	......	......	......	......	3½	3½
Agnes	20.2	......	......	......	......	3	3
Ida	20.2	......	......	......	......	3	3
3D PERIOD.							
Jansje	21.5	......	2	4	2	......	......
Nancy	21.5	......	1¾	3½	1¾	......	......
Queen Linda	20.5	......	1¾	3½	1¾	......	......
Agnes	20.5	......	1½	3	1½	......	......
Ida	20.5	......	1½	3	1½	......	......

COMPOSITION OF THE FOODS.

	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fats.
CXLII, Cotton-seed Meal	9.30	6.95	44.62	5.56	23.43	10.14
CXLV, Linseed Meal, O. P.	9.35	5.01	36.19	7.89	33.71	7.85
CXLIII, Pea Meal	15.11	4.17	19.56	5.75	53.49	1.92
CXLIV, Barley	14.42	6.42	9.31	10.54	54.97	4.34

YIELD OF MILK.

	Jansje.	Nancy.	Queen Linda.	Agnes.	Ida.	Total.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Feb. 8th—14th	126	108	210	136	129	709
" 15th—21st	134	100	212	133	124	703
" 22d—28th	131	100	197	133	127	688
March 1st—7th	125	89	188	115	108	625
" 8th—14th	123	94	183	118	107	625
" 15th—21st	125	99	176	116	114	630
" 22d—28th	125	99	181	125	114	644
" 29th—April 4th	128	96	179	123	110	636
April 5th—11th	119	99	172	125	106	621

COMPOSITION OF MILK.

	Total solids.	Ash.	Albuminoids.	Sugar.	Fat.
			JANSJE.		
Feb. 9th—13th, C. S. meal mixture	13.11	.65	3.41	5.33	3.72
March 9th—13th, peas and barley	13.14	.65	3.78	4.77	3.94
April 13th—17th, Linseed meal mixture,	13.04	.65	3.60	5.02	3.77
			NANCY.		
Feb. 9th—13th	12.57	.65	3.46	4.67	3.79
March 9th—13th	12.40	.65	3.38	4.89	3.48
April 13th—17th	12.20	.65	3.35	4.61	3.59
			QUEEN LINDA.		
Feb. 9th—13th	12.40	.65	3.10	5.12	3.32
March 9th—13th	12.16	.65	2.89	5.34	3.28
April 13th—17th	12.04	.65	2.93	5.21	3.25
			AGNES.		
Feb. 9th—13th	14.46	.75	3.90	5.15	4.66
March 9th—13th	14.26	.75	3.94	4.78	4.79
April 13th—17th	13.84	.75	3.79	4.77	4.53
			IDA.		
Feb. 9th—13th	14.59	.75	3.80	4.74	5.30
March 9th—13th	14.23	.75	3.72	4.74	5.02
April 13th—17th	14.36	.75	3.85	4.50	5.23

POUNDS OF OTHER SOLIDS WITH EACH 100 LBS. OF FAT.

	Jansje.	Nancy.	Queen Linda.	Agnes.	Ida.
1st Period	252	232	273	210	175
2d Period	232	256	271	198	183
3d Period	246	240	270	205	174

Pounds of Fat for Each 100 lbs. Albuminoids.

	Jansje.	Nancy.	Queen Linda.	Agnes.	Ida.
1st Period	109	109	107	119	137
2d Period	104	103	114	122	135
3d Period	105	107	111	119	136

Melting Points of Butter.

	Centigrade temperature.			Fahrenheit temperature.		
	Cotton-seed, corn meal and wheat bran.	Peas and barley.	Linseed, corn meal and wheat bran.	Cotton-seed, corn meal and wheat bran.	Peas and barley.	Linseed, corn meal and wheat bran.
	deg.	deg.	deg.	deg.	deg.	deg.
Jansje—Holstein	36.3	33.6	34.2	97.2	92.5	93.6
Nancy—Ayrshire	35.	33.1	32.2	95.	91.6	90.
Queen Linda—Ayrshire	34.	32.1	33.1	93.2	89.8	91.6
Agnes—Jersey	34.2	35.1	33.6	93.6	95.2	92.5
Ida—Jersey	35.	33.9	35.2	95.	93.	95.4

Volatile Acids.

	Cotton-seed, corn meal and wheat bran.	Peas and barley.	Linseed, corn meal and wheat bran.
Jansje—Holstein	28.7	28.7	28.3
Nancy—Ayrshire	32.8	28.9	28.7
Queen Linda—Ayrshire	32.8	30.6	30.4
Agnes—Jersey	28.8	28.2	26.2
Ida—Jersey	30.4	27.7	28.6

Iodine Equivalent.

	Cotton-seed, corn meal and wheat bran.	Peas and barley.	Linseed, corn meal and wheat bran.
Jansje—Holstein	31.5	27.3	32.
Nancy—Ayrshire	32.4	30.5	34.8
Queen Linda—Ayrshire	33.9	28.8	30.2
Agnes—Jersey	28.	23.	30.5
Ida—Jersey	26.1	25.3	25.6

The grain foods of the first period constituted the regular grain rations which the animals had been receiving for more than two years. During the entire time of these periods a record was made of the yield of milk. On five days in each period the milk was analyzed, as was also the skimmed milk from the cold setting process. The five days' cream was churned and the resulting butter was tested for the melting point, the per cent. of volatile acids and the iodine equivalent or per cent. of olein. The facts that are displayed in the preceding tables show:

(1.) Yield of milk.

(2.) Its general composition.

(3.) The relation of the fats to the albuminoids and to the other solids.

(4.) The melting point of the butter fats.

(5.) The relative amount of volatile acids.

(6.) The iodine equivalent or amount of olein.

The results reached in this experiment are not striking, neither are they easy to explain. There was a somewhat diminished yield of milk in passing from the first to the second periods, while the composition of the milk remained unchanged or practically so throughout. Not only did the total amount of solids in the milk remain about the same with the different methods of feeding, but the relation in quantity of the various solids did not change greatly, and whatever changes of this kind did occur were evidently not caused by the food.

It was remarked by both the butter maker and by the chemist who handled the butter in the laboratory, that the butter of the second period was softer than that of the first. We would, therefore, expect to find a lower melting point during the second period and this proves to be the case with the exception of one animal. With part of the animals the volatile acids changed somewhat in passing from one period to another, but these changes are evidently entirely without reference to the character of the ration. There is only one test which gives results that are significant, namely: The test for olein. It appears that the iodine equivalent is uniformly less during the second period than during the first and third, and the differences are quite marked. It is difficult to reconcile this fact with the softer appearance of the butter and the lower melting point. When the olein or liquid fat diminishes in quantity we would expect harder butter and a higher melting point.

Evidently the changes which occurred in the composition of the butter are somewhat complex and were not wholly discovered by the tests which were applied.

SUMMARY.

(1.) Five cows, including one Holstein, two Ayrshires and two Jerseys, were fed three different rations during as many periods.

(2.) The grain ration of the first period consisted of a mixture of cotton-seed meal, corn meal and wheat bran; during the second period, of peas and barley, and during the third period cf linseed meal, corn meal and wheat bran.

(3.) The amount of milk was diminished somewhat in passing from the first to the second period, and increased slightly after changing to the third period.

(4.) The composition of the milk varied but little and no more, or even less, during the three periods, than is often observed when the ration is not changed.

(5.) The relation in quantity in fats to the other solids varied somewhat, but apparently without reference to the food.

(6.) With four of the cows the melting point of the butter was considerably lower during the second period than during the first.

(7.) The relative amount of volatile acids varied only within quite narrow limits and apparently was not affected by the food.

(8.) With all the cows the percentage of olein (liquid fat) was apparently considerably less during the second period, when the peas and barley were fed, than during the first and third periods.

Even though it is possible to draw only limited conclusions from this experiment, some practical suggestions appear:

(1.) Quite radical changes may be made in the kind ol grain ration fed, without affecting the quality of the milk.

(2.) The tendency of butter to melt during hot weather may be influenced by the kind of food, and also the degree of hardness may be affected.

(3.) A mixture of Cotton-seed Meal or Linseed Meal with Corn Meal and Wheat Bran, especially the C. S. Meal mixture, produced butter less easily melted, and of a more solid appearance, than did the Peas and Barley.

OTHER OBSERVATIONS ON THE EFFECT OF FOOD UPON BUTTER.

Ladd, at the New York State Experiment Station (Rep. 1888 p. 291) investigated the effect of introducing Linseed Meal into the ration and found an increase in the iodine number and also in the viscosity. Harrington, at the Texas Experiment Station (Rep. 1889, p. 100), found that a grain ration entirely of Cotton-seed Meal raised the melting point of the butter and also the per centage of volatile acids. He sent samples of the same butter to Prof. Wiley of the U. S. Department of Agriculture, whose examination (see Rep. Dept. Agr. 1889, p. 181) corroborated Harrington's results and showed, moreover, that the iodine number for the Cotton-seed butter was higher than for the other. A second set of samples received by Wiley from Harrington did not show such marked results. Prof. Wiley subsequently made an investigation (loc. cit. p. 184) in co-operation with the Maryland Experiment Station, and he found here that the Cotton-seed caused an elevation of the melting point and a lowering of the percentage of volatile acids. The iodine number, contrary to the previous investigations, was diminished rather than increased by the feeding of Cotton-seed.

An experiment conducted by the New Hampshire Experiment Station (see Bulletin No. 13) indicated that cotton-seed meal increased the hardness of the butter, that gluten meal produced a softer butter than corn meal, ensilage a softer butter than hay, and that there is a more or less definite relation between hardness and the iodine absorption number. The opinion was also expressed that the results showed no definite relation between the melting point and the hardness.

Mayer, a German chemist, has made quite an elaborate investigation (Landw. Vers. Stat. Vol. 35, p. 261) and he reached the following conclusions:

(1.) The amount of volatile fatty acids in butter rises and falls with the rise and fall of the specific gravity.

(2.) The melting point of butter depends more upon the amount of olein in butter than upon the amount of butyrin, capronin, etc. (compounds of the volatile acids), present.

(3.) The content of volatile fatty acids in butter varies for an individual cow within wide limits.

(4.) The content of volatile fatty acids in butter fat is dependent upon the period of lactation (length of time the cow has been milked) and diminishes in general with the advance of the same.

(5.) The content of volatile acids is dependent to a great extent upon the food.

(6.) The melting point is also influenced by the food.

The results which have been reviewed above are to quite an extent discordant and a close study of them may well be an occasion for perplexity. What appears to be true from the results of one investigator does not hold in another case. One fact, however, seems to be quite clearly indicated, which is, that the presence of Cotton-seed Meal in the grain ration gives to the butter a higher melting point, or in other words, increases its resistance to the effects of hot weather. It also seems that when the grain ration consists wholly, or nearly so, of Cotton-seed Meal, the percentage of volatile acids is considerably lowered. What effect this has on the quality of the butter is not as clear. It would not be safe, certainly, with present knowledge, to make very many assertions with regard to the specific effect of this or that food upon the composition and physical characteristics of butter.

MAINE AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 3.

SECOND SERIES.

THE BABCOCK MILK TEST ADAPTED TO TESTING CREAM.

J. M. BARTLETT.

During the past few years several simple and accurate methods for estimating fat in milk, adapted to the use of creameries and cheese factories, have been devised by different chemists. Most of these methods are very useful in testing milk and can be used for testing cream, but none of them seem to be especially adapted to the latter purpose and consequently are of no great value to creameries that collect cream only. The need of some method for determining the value of each patron's cream is now acknowledged by every one that has had much experience with creameries.

Even if the patrons of a creamery all use the cold deep setting process and are careful to keep the water at about 40° at all times, the cream from different animals or herds may vary several per cent.

Fifty samples of cream raised by this process, collected by creameries, were tested at the Conn. Exp't. Station and showed a variation of six per cent. of butter fat. One sample contained 23.8 per cent. another 17.78 per cent.

The temperature at which the milk is kept makes a very great difference in the quality of the cream. If the water in which the cans are submerged is allowed to become warm the cream will be much richer than when it is kept cold. The percentage of fat in cream from the same cows may be increased ten per cent. or more by keeping the water at 70° instead of 40°. Several samples collected by a creamery agent were tested. The lowest yield of fat was 12 per cent. and the highest 30 per cent.

The most of the samples gave from 17 per cent. to 22 per cent.

If this creamery had allowed equal amounts of butter for every inch of cream a great injustice would have been done to some of the patrons.

The writer has for the past few months devoted what limited time could be spared from other station work to studying methods with the idea of especially adopting some one for testing cream. As a result of this investigation the method devised by Dr. Babcock of the Wisconsin Experiment Station was selected, it being more simple and rapid than any that had appeared at the time of beginning this work.

Since that time the Beimling method has been brought out and by some is considered equally good, but the apparatus is a little more expensive. The Babcock method is fully explained in Bulletin No. 24 of Wisconsin Experiment Station, therefore it is only briefly described here. The milk is measured into a test bottle with a graduated neck, and about an equal amount of sulphuric acid is added, which dissolves all solids except the fat. The bottle is then at once whirled in a centrifugal machine to collect the fat on the surface of the liquid. Hot water is then added to raise the fat into the graduated part of the neck of the bottle, where the percentage can be read. The bottle used in the milk test as devised by Dr. Babcock is graduated to estimate no higher than 10 per cent. of fat, and as cream usually contains much more than that, it is evident this bottle cannot be used, if the same quantity (18 grams) is taken for the test.

To take a smaller quantity increases the liability to error and impairs the accuracy of the results. A pipette one third the size used for milk, made to deliver about six grams of cream, was first tried, but so much care was necessary to obtain good results the idea was abandoned. In reading a long column of fat, unless one is expert and very careful to keep the temperature constant, he is liable to make an error of 0.2 or 0.3 per cent., and when only six grams of cream are used the reading must be multiplied by three, which increases the error three-fold. Dr. Babcock recommends using three bottles, dividing the pipette full into three parts, putting one third into each bottle and adding the three readings. This method involves so much work that it would not be pratical in testing a large number of samples. To overcome these difficulties the writer used a bottle like No. 2, graduated to read from 0.2 to 25 per cent. of fat, the bulb on the neck holding 10 per cent. With this bottle cream containing not more than 25 per cent. of fat can be as easily and accurately tested as milk, and as cream raised in deep cans submerged in cold water very seldom contains much over 20 per cent. these bottles are sufficiently large to answer the purpose of our creameries. Very rich cream containing over 25 per cent. fat may be diluted one half with water, or a 9c. c. pipette can be used and the readings multiplied by 2., but can be more accurately tested with a bottle like No. 3 described later on.

These test bottles can be used just as well for milk, so another set is not necessary. Bottle No. 2 cannot however be used in the regular size centrifugal machine as it is about one and one-half inches longer than the bottles used for milk testing.

A bottle of the same style, graduated to read to 23 per cent. may be used in the regular size machine.

No. 3 represents a bottle designed for testing very rich cream without reducing the quantity used for the test. Such cream, carrying over 30 per cent. fat, is frequently obtained from the separator or from milk kept at a temperature of about 60° or 70°. This bottle as is shown by the diagram is made in two pieces and is graduated to read to 35 per cent. It has some advantages over the other kinds for the reason the base is the portion most liable to breakage, and is separate from the more expensive graduated neck. One could have a large number of the bases and not require more than a dozen of the graduated necks to operate them successfully.

Testing Cream.

Sampling.

The first and one of the most important parts of the process is sampling the cream, for it is plain that unless this is properly done and the portion taken for the test correctly represents the whole, the results that follow must necessarily be incorrect. The lot of cream to be sampled should be put in a can or some vessel sufficiently large to hold it all, and another vessel of equal size being at hand, it should be turned alternately from one to the other four or five times to thoroughly mix and make it homogeneous. The sample must be immediately taken after the mixing is done, and put in a vessel properly labeled and suitable for the purpose. A half pint fruit jar answers the purpose well, which must be filled full to avoid churning.

How often should tests be made?

In order to be *very* accurate and ascertain exactly the amount of fat in each patron's cream, it would be necessary to take a sample from every lot collected—a definite amount, 1 oz. for every inch or quart furnished, should be taken. That is, if a patron furnishes six quarts to-day six ounces should be taken for the sample, and if he furnishes ten quarts to-morrow ten ounces should be taken for the sample.

These samples can be kept sweet in an ice chest for a week and then be thoroughly mixed together and tested. The result will accurately represent the per cent. of fat in the cream for that week. Many creameries cannot afford the time to collect samples and make tests so often, and it is not necessary if the patrons will exercise a little care to keep the water surrounding the milk cans always at the same temperature as nearly as possible. A test made once in two or three weeks will then suffice and give a sufficiently accurate basis on which to value the cream. It would be advisable to take samples for three successive days and mix them for the test. This would give a more accurate result than if only one sample was taken.

Performing the test.

With sweet cream that is not frothing, the method does not vary from that described for milk when the test bottle like No. 2 is used. A copy of these directions is furnished with each machine so a description is not necessary here. In adding hot water to the test bottles the first time, I find it most convenient to fill them to about the 20 per cent. mark, then one can easily see how much to add the second time to bring the fat where it can be measured. The measuring pipette is the same as that used for milk except it has two marks on it. The lower one (17.6) is to be used in measuring milk, the upper one (18) for measuring cream. From this latter mark the pipette delivers 18 grams of cream, raised in cans submerged in cold water, with sufficient accuracy for all practical purposes. For testing richer cream, a correction must be made because of the weight of cream delivered by the pipette decreases as the per cent. of fat increases.

For a scale reading of 25 per cent. add 0.15 per cent.; for a scale reading of 30 per cent. add 0.3 per cent. Readings between or above these may be corrected proportionately.

If the cream to be tested has become sour and curdled so it can not be handled with a pipette, it can be rendered mobile by placing the jar containing it in water and heating the whole to about 125° F., then passing the cream through fine wire gauze, (a flour sieve will do very well for the purpose.) Any lumps that remain on the sieve may be rubbed through with the finger. After passing the warm cream through the sieve two or three times, it will after cooling, be in condition to measure with the pipette. On account of the small particles of curd, sour cream adheres much more to the walls of the pipette than sweet cream, therefore a little water (4 or 5 c.c.) must be used to rinse the pipette into the test bottle. Unless this is done the results will be from 0.2 to 0.4 per cent. too low. About 20c. c. of acid should be used when the pipette is rinsed. When the cream is frothing badly and contains a large amount of air or gas bubbles, as is sometimes the case with cream that is very sour or taken from a separator, it cannot be accurately measured but must be weighed. The writer has made several tests when the error in measuring frothy cream was over 5 per cent. of the total fat.

The only accurate method to pursue in such cases is to weigh the cream, and this can be very easily done by any one who has skill enough to make the test. A good little scale for the purpose is made by the Springer Tortion Balance Co., 92 Reade St., N. Y. Their No. 302 Handy Scale, costing about $4.00 with a weight that when put on the 8 oz. notch weighs 18 grams, is sufficiently accurate and very convenient. We would advise creameries using this test to get a scale for the purpose mentioned, for there will be instances when it will save much time and trouble. The method of using the scale is very simple. The empty test bottle is set on the pan and counterpoised by means of the ounce weight and screw at the end of the scale arm; then the 18 gram weight is put on the 8 oz. notch, the pipette filled with cream a little above the mark and emptied into the test bottle until it is nearly all in, when the finger is pressed on the top of the pipette sufficiently to allow the cream only to drop slowly till the scale turns. One can weigh with a little practice about as rapidly as he can measure. This scale will also be very convenient in testing butter and cheese, as with solids it is necessary to weigh out the portions for the test.

In using the test bottle No. 3 the method is slightly modified in the latter part of the process. The base portion, into which has been measured the cream and acid, is put in the centrifugal machine and whirled for five minutes the same as with the ordinary bottles. As much hot water is then added as the base will hold without danger of spilling, and whirled for two or three minutes more, to collect the fat on the top of the water. The base is then taken and connected with the graduated neck by a piece of rubber tubing. The whole is then put in a tank or pail of water, heated to about 110 to 120 F. and the fat raised into the neck by turning gently down the side hot dilute acid in sufficient quantity to fill the bottle to about the 34 mark. The fat usually rises and forms a compact column in two or three minutes so that by the time the 10th or 12th bottle is put into the warm water, the first can be read, giving directly the per cent. of fat.

The dilute acid consists of one part by volume of strong acid to one part of water. In mixing, the water must always be put in the vessel first and the acid turned into it. If used immediately it will need no extra heating, as sufficient heat is developed in the mixing. We have only had opportunity to make 12 or 15 tests with this bottle, but they seem to indicate that it is accurate as can be seen by the table below.

One cannot work quite as rapidly as with bottle No. 3 therefore we would advise its use only on very rich cream containing over 25 per cent. of fat.

This form of bottle (No. 3.) can be used in the regular size machine.

Where To Obtain The Apparatus.

Arrangements have been made with Cornish, Curtis & Greene, Fort Atkinson, Wis., manufacturers of the milk test apparatus, to furnish the modified apparatus to parties who may desire it at about the same price as the ordinary form.

Parties ordering the cream tester, must be particular to mention what they want or otherwise they may receive the wrong machine. Any of the pieces of glass-ware can be obtained of Emil Greiner, N. Y., and should be ordered by number, then no mistake can be made.

Cream Test bottle No. 1 is for use in the regular size milk testing machine and reads to 23 per cent.

Cream Test bottle No. 2 is for use in the machine especially made for the purpose and reads to 25 per cent.

Cream Test bottle No. 3, is for testing rich cream, can be used in either machine and reads to 35 per cent.

Sulphuric acid can be obtained of wholesale druggists, or dealers in chemicals. The Cochrane Chemical Co., Boston, Mass., sells commercial acid, specific gravity, 1.835, in carboy lots at very reasonable prices. Acid of this strength should be slightly diluted by adding about twenty parts of acid to one part of water by volume.

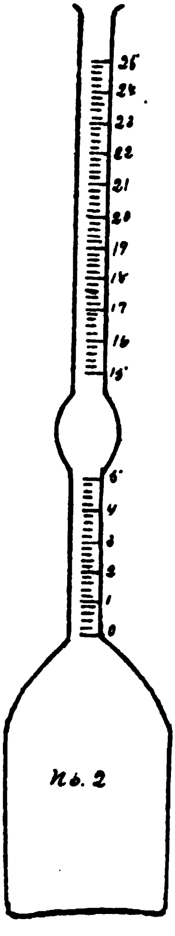
	Gravimetric Method.	Test Bottle with Bulb Neck.	Test Bottle with Separable Neck.
Cream No. 1..........	18.4	18.4	18.45
" "		18.35	18.40
" "			18.35
" "			18.40
" No. 2..........	14.3	14.1	14.0
" "	"	14.2	14.3
" "	"	14.1	
" "	"	14.3	
" No. 3..........	19.6	19.3	19.3
" "	19.7	19.3	19.5
" "	"	19.2	
" "	"	19.7	
" "	"	19.6	
" "	"	19.8	
" No. 4..........	18.62	18.4	
" No. 5..........	18.6	18.5	
" No. 6..........	20.4	20.1	20.0
" No. 7.	19.75	19.6	19.6
" "	"	19.6	19.8
" "	"	19.8	19.8
" "	"	19.9	19.9
" "	"	19.7	19.7

NOTE.—The object of this bulletin is to call attention to an accurate and rapid method of determining the percentage of fat in milk and cream. The apparatus as originally described by Dr. Babcock has been modified by Mr. Bartlett to meet the needs of creamery work in Maine and the new forms of testing flasks that have been devised are favorably regarded by Dr. Babcock. The Experiment Station does not assume that the managers of creameries are ready to value their patrons cream on the basis of the actual percentages of fat, neither does it propose at this time to urge such a course, for that is a purely business matter, but it seems very desirable that in case any creamery management should conclude to apply the only just standard of valuation, some practical method for doing this should be at hand. This bulletin presents such a method.

Should any creamery manager or private dairyman wish to purchase and put into operation the Babcock apparatus, the Experiment station will be glad to render all the assistance possible, either through suggestions about the purchase of, or instruction in the use of, the apparatus. Prompt attention will be given to all inquiries in regard to the matter.

W. H. JORDAN.
DIRECTOR.

ORONO, ME.,
Sept. 1st, 1891.



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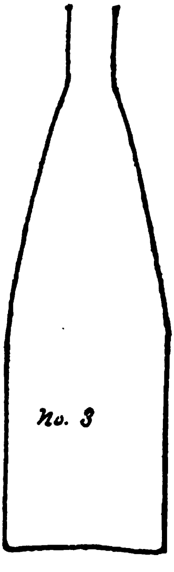

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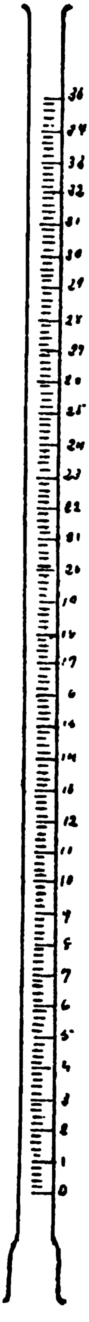

FURTHER REMARKS ON THE BABCOCK CREAM TEST.

J. M. BARTLETT.

Since Bulletin No., 3 was issued, many inquiries from parties interested in creameries have been received, and while a few creameries have already obtained and are successfully using the Babcock test, there still seems to be a grave doubt in the minds of some as to the practicability of applying a test that gives the value of the cream in butter fat instead of in butter. Again, when the cream is bought by the inch, measured in the cans as it stands on the milk, and then is sampled for the test after its volume has been increased by a small amount of skimmed milk drawn off in the skimming, the per cent. of fat obtained is too small. In regard to the first mentioned difficulty, it is unnecessary to consider the amount of butter the cream will make; nevertheless, if some insist on using the butter valuation, they will not come far from the truth if they consider that butter is 85 per cent. fat, or that 85 pounds of fat will make one hundred pounds of butter.

Cream for butter making is only valuable for the amount of butter fat it contains, and there seems to be no good reason why cream that contains 30 per cent. fat should not make twice as much butter as that containing 15 per cent. and why the one is not worth twice as much per inch as the other. We therefore claim that the only true basis for valuation is the butter fat content.

Cream from the milk of different cows or even herds, raised by the cold deep setting process, often varies five or six per cent. in fat under the most favorable conditions. If, then, a creamery buys cream at 15 cents an inch and Mr. A's cream contains 20 per cent. butter fat and Mr. B's 25 per cent., then A receives 75 cents for the same butter fat for which B receives but 60 cents.

It certainly seems to be more just and business like to pay a fixed price per unit for butter fat of known value, than to pay uniform rates per unit for cream of unknown value. Objections to the fat valuations have also been made on the ground that some cream churns with difficulty, especially that from cows advanced in lactation. This would be a valid objection providing each lot of cream was churned by itself, but it has been pretty well proved by experiment that when cream of poor churning qualities is ripened and churned with good cream, the separation of butter is just as complete, and no more fat is left in the butter milk, than when all good cream is churned.

In regard to making the test when cream is bought by the inch, it can be said that it makes no difference whether the cream is bought by the inch, gallon, or pound. If, according to the common practice in this State, the cream is measured as it stands on the milk in the can, all that is necessary is to draw the cream off into another can or pail of the proper diameter and make a second measurement in order to know how much milk has been drawn with it. The sample is taken from the thoroughly mixed cream after it is drawn off and having the two measurements the calculations is very simple.

If the cream measured 8 inches in the can and 10 inches after being drawn off with some skim milk and tested 20 fat, then to find the per cent. of fat in the cream before any milk was mixed with it we have the simple proportion 8 :10 : :20 :x.

X in this case equals 25 per cent.

If a patron of a creamery furnished 100 inches of cream for a week that tested as above, then he would be entitled to 25 units of butter fat.

Some creameries draw the cream off into a collector's pail before measuring, while others buy it by the gallon. With these methods a second measurement is not necessary when the sample is taken for the test.

Some creameries are co-operative and the butter receipts are divided among its patrons. In such cases the test can be used equally well for a proper division of the proceeds. Suppose A. B. and C. are patrons and

A	furnishad	100	in.	cream,	testing	20% =	20 units.
B	"	200	"	"	"	25% =	50 "
C	"	500	"	"	"	18% =	90 "
		Total,					160 "

From this cream 380 lbs. of butter are made.

Then A's	share is	2-16	of	380	lbs., =	47½ lbs.
B's	"	5-16	"	380	" =	118¾ "
C's	"	9-16	"	380	" =	213¾ "

INTERIOR OF EXPERIMENT STATION LABORATORY, LEFT SIDE.

INTERIOR OF EXPERIMENT STATION LABORATORY, RIGHT SIDE.

APPENDIX.

HUNGARIAN GRASS, CXXI.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
				Sheep 1.			
Fed daily	556.	504.4	51.5	61.4	170.5	254.	18.4
Excreted daily	216.8	184.5	32.3	24.4	58.9	92.9	8.3
Digested	339.2	319.9	19.2	37.0	111.6	161.1	10.1
Per cent. digested	61.0	63.4	37.2	60.2	65.4	63.5	54.9
				Sheep 2.			
Fed daily	556.	504.4	51.5	61.4	170.5	254.	18.4
Excreted daily	208.4	176.	32.4	24.9	56.5	84.9	9.6
Digested	247.6	328.4	19.1	36.5	114.0	169.1	8.8
Per cent. digested	62.5	65.1	37.0	59.4	66.8	66.7	47.8
				Sheep 3.			
Fed daily	556.	504.4	51.5	61.4	170.5	254.	18.4
Excreted daily	205.	175.3	29.6	22.3	54.8	89.2	9.1
Digested	351.0	329.1	21.9	39.1	115.7	164.8	9.3
Per cent. digested	63.1	65.2	42.5	63.6	67.2	64.8	50.5
				Sheep 4.			
Fed daily	556.	504.4	51.5	61.4	170.5	254.	18.4
Excreted daily	183.2	157.2	26.	20.6	48.1	80.3	8.0
Digested	372.8	347.2	25.5	40.8	122.4	173.7	10.4
Per cent. digested	67.0	68.8	49.5	66.4	71.7	68.4	56.

HUNGARIAN HAY, CXXVIII.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
				Sheep 1.			
Fed daily	655.5	598.8	56.6	70.9	191.7	311.4	24.8
Excreted daily	228.9	199.4	29.5	28.4	60.7	101.3	8.9
Digested	426.6	399.4	27.1	42.5	131.0	210.1	15.9
Per cent. digested	65.8	66.8	47.9	59.9	68.5	67.4	63.9
				Sheep 3.			
Fed daily	655.5	598.8	56.6	70.9	191.7	311.4	24.8
Excreted daily	234.1	204.	30.1	28.3	63.5	103.1	9.
Digested	421.6	394.8	26.5	42.6	128.2	208.3	15.8
Per cent. digested	64.3	65.9	46.9	60.0	66.8	66.9	63.8

SOUTHERN CORN FODDER, CXXVII.

Sheep 2.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed daily	504.7	461.5	43.1	55.5	154.7	236.4	14.8
Excreted daily	149.6	131.7	18.	18.8	38.7	70.0	4.1
Digested	355.1	329.8	25.1	36.7	116.0	166.4	10.7
Per cent. digested	70.3	71.4	58.2	66.1	74.9	70.4	72.3
			Sheep 4.				
Fed daily	504.7	461.5	43.1	55.5	154.7	236.4	14.8
Excreted daily	158.4	139.8	18.7	19.6	40.8	74.8	4.5
Digested	346.3	321.7	24.4	35.9	113.9	161.6	10.3
Per cent. digested	68.6	69.8	56.6	64.7	73.6	68.7	69.6

FIELD CORN FODDER, CXXV.

Sheep 1.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed daily	403.2	372.5	30.7	45.2	102.5	211.4	13.3
Excreted daily	113.6	100.3	13.4	16.	24.3	56.2	3.8
Digested	289.6	272.2	17.3	29.2	78.2	155.2	9.5
Per cent. digested	71.8	73.7	56.3	64.6	76.3	73.4	71.4
			Sheep 3.				
Fed daily	403.2	372.5	30.7	45.2	102.5	211.4	13.3
Excreted daily	123.1	107.6	15.5	18.5	25.6	59.4	4.1
Digested	280.1	264.9	15.2	26.7	76.9	152.0	9.2
Per cent. digested	69.4	71.1	49.5	59.0	75.0	71.9	69.1

SWEET CORN FODDER, CXXVI.

Sheep 2.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed daily	407.2	398.6	28.6	55.1	104.4	203.5	15.7
Excreted daily	124.7	106.7	18.	21.9	24.1	57.4	3.3
Digested	282.5	291.9	10.6	33.2	80.3	146.1	12.4
Per cent. digested	69.3	73.2	37.0	60.2	76.9	71.8	78.8
Sheep 4.							
Fed daily	407.2	398.6	28.6	55.1	104.4	203.5	15.7
Excreted daily	121.	104.4	16.6	20.1	24 4	55.8	4.0
Digested	286.2	294.2	12.0	35.0	80.0	147.7	11.7
Per cent. digested	70.2	73.9	41.9	63.5	76.6	72.5	74.5

TIMOTHY—MIXED CXL.

Sheep 1.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed daily	646.6	614.3	32.3	48.1	211.0	324.3	30.8
Excreted daily	266.5	242.5	24.0	28.	97.2	109.7	7.4
Digested	380.1	371.8	8.3	20.1	113.8	214.6	23.4
Per cent. digested	58.7	60.5	25.7	41.9	53.9	66.1	75.9
Sheep 2.							
Fed daily	646.6	614.3	32.3	48.1	211.0	324.3	30.8
Excreted daily	283.5	261.3	22.3	26.9	106.4	118.9	8.9
Digested	363.1	353.0	10.0	21.2	104.6	205.4	21.9
Per cent. digested	56.1	57.4	30.9	44.0	49.6	63.3	71.1
Sheep 3.							
Fed daily	646.6	614.3	32.3	48.1	211.0	324.3	30.8
Excreted daily	243.	222.5	20.5	24.2	83.7	107.3	7.5
Digested	403.6	391.8	11.8	23.9	127.3	217.0	23.3
Per cent. digested	62.4	63.7	36.5	49.8	60.3	66.9	75.6
Sheep 4.							
Fed daily	646.6	614.3	32.3	48.1	211.0	324.3	30.8
Excreted daily	276.9	252.9	24.1	28 4	80.4	136.2	7.8
Digested	369.7	361.4	8.2	19.7	130.6	188.1	23.0
Per cent. digested	57.1	58.8	25.4	40.9	61.9	58.0	74.6

TIMOTHY HAY, CXLI.

Sheep 1.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed daily	646.6	610.	36.5	46.8	212.4	324.2	26.6
Excreted daily	274.8	251.3	23.5	25.6	99.5	118.9	7.3
Digested	371.8	358.7	13.0	21.2	112.9	205.3	19.3
Per cent. digested	57.5	58.8	35.6	45.3	53.1	63.3	72.5

Sheep 2.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed daily	646.6	610.	36.5	46.8	212.4	324.2	26.7
Excreted daily	266.9	243.5	23.4	26.5	98.8	110.3	7.8
Digested	379.7	366.5	13.1	20.3	113.6	213.9	18.9
Per cent. digested	58.7	60.0	35.9	43.3	53.5	65.9	70.7

Sheep 3.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed daily	646.6	610.	36.5	46.8	212.4	324.2	26.6
Excreted daily	267.7	246.5	21.2	23.5	96.7	117.8	8.2
Digested	378.9	363.5	15 3	23.3	115.7	206.4	18.4
Per cent. digested	58.6	59.6	41.9	49.8	54.5	63.7	69.2

Sheep 4.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed daily	594.6	560.4	34.2	43.9	194.5	297.	24.9
Excreted daily	229.7	211.1	18.6	21.1	81.0	100.8	8.2
Digested	364.9	349.3	15.6	22.8	113.5	196.2	16.7
Per cent. digested	61.3	62.3	45.6	51.9	58.3	66.0	67.0

SUGAR BEETS, CXXXIII.

Sheep 1.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed in hay, CXL, daily	461.8	438.8	23.	34.4	750.7	231.6	22.
Fed in beets daily	325.	302.8	22.2	31.2	17.4	251.4	2.8
Total fed	786.8	741.6	45.2	65.6	168.1	483.	24.8
Excreted daily	210.5	181.6	28.8	22.3	67.7	84.7	7.0
Total digested	576.3	560.0	16.4	43.3	100.4	398.3	17.8
Digested from hay	270.1	263.7	6.8	15.2	85.	147.3	16.3
Digested from beets	306.2	296.3	9.6	28.1	15.4	251.0	1.5
% digested from beets	94.2	97.6	43.2	90.0	88.5	99.8	53.5

Sheep 3.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Total fed	786.8	741.6	45.2	65.6	168.1	483.	24.8
Excreted daily	208.7	174.9	33.8	21.5	63.3	82.7	7.2
Total digested	578.1	566.7	11.4	44.1	104.8	400.3	17.6
Digested from hay	270.1	263.7	6.8	15.2	85.	147.3	16.3
Digested from beets	308.	303.0	4.6	28.9	19.8	253.0	1.3
% digested from beets	94.8	99.9	20.7	92.6	11.3	10.0	46.4

MANGOLDS, CXXXII.

Sheep 2.

	Dry substance.	Organic matter.	Ash	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed in hay, CXL, daily	461.8	438.8	23.	34.4	150.7	231.6	22.0
Fed in beets daily	234.6	212.4	22.2	24.8	14.6	170.6	2.2
Total fed	696.4	651.2	45.2	59.2	165.3	402.2	24.2
Excreted daily	245.4	211.7	33.7	26.7	76.4	99.9	8.7
Total digested	451.0	439.5	11.5	32.5	88.9	302.3	15.5
Digested from hay	270.1	263.7	6.8	15.2	85.	147.3	16.3
Digested from beets	180.9	175.8	4.7	17.3	39.	155.0	......
% digested from beets	77.1	82.7	21.1	69.7	26.8	90.8	......

Sheep 4.

	Dry substance.	Organic matter.	Ash	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Total fed	696.4	651.2	45.2	59.2	165.3	402.2	24.2
Excreted daily	238.5	202.7	35.8	24.2	71.7	98.1	8.6
Total digested	457.9	448.5	9.4	35.0	93.6	304.1	15.6
Digested from hay	270.1	263.7	6.8	15.2	85.	147.3	16.3
Digested from beets	187.8	184.8	2.6	19.8	8.6	156.8	......
% digested from beets	80.	87.0	11.7	79.8	58.8	91.9	......

RUTABAGAS, CXXX.

Sheep 1.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed in hay, CXL, daily	461.8	438.8	23.	34.4	150.7	231.6	22.
Fed in turnips daily	219.	204.6	14.4	17.8	20.	156.	10.8
Total fed	680.8	643.4	37.4	52.2	170.7	387.6	32.8
Excreted daily	213.5	189.4	24.	21.7	68.2	92.9	6.6
Total digested	467.3	454.0	13.4	30.5	102.5	294.7	26.2
Digested from hay	270.1	263.7	6.8	15.2	85.	147.3	16.3
Digested from turnips	197.2	190.3	6.6	15.3	17.5	147.4	9.9
% digested from turnips	90.0	93.0	45.8	85.9	87.5	94.4	91.6

Sheep 3.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Total fed	680.8	643.4	37.4	52.2	170.7	387.6	32.8
Excreted daily	225.5	197.2	28.2	23.7	73.5	91.8	8.2
Total digested	455.3	446.2	9.2	28.5	97.2	295.8	24.6
Digested from hay	270.1	263.7	6.8	15.2	85.	147.3	16.3
Digested from turnips	185.2	182.5	2.4	13.3	12.2	148.5	8.3
% digested from turnips	84.5	89.2	16.7	74.7	61.	95.1	76.8

ENGLISH FLAT TURNIPS, CXXXI.

Sheep 2.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed in hay, CXL, daily	461.8	438.8	23.	81.4	150.7	231.6	22.
Fed in turnips daily	195.2	176.8	18.4	22.	20.4	126.4	8.
Total fed	657.0	615.6	41.4	56.4	171.1	858.0	30.
Excreted daily	209.8	187.	22.8	22.6	67.9	89.3	7.1
Total digested	447.2	428.6	18.6	33.8	103.2	268.7	22.9
Digested from hay	270.1	263.7	6.8	15.2	85.	147.3	16.3
Digested from turnips	177.1	164.9	11.8	18.6	18.2	121.4	6.6
% digested from turnips	90.7	93.2	64.1	84.5	89.2	96.0	82.5

Sheep 4.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Total fed	657.0	615.6	41.4	56.4	171.1	858.0	30.
Excreted daily	201.6	176.8	24.8	20.3	62.2	88.	6.3
Total digested	455.4	438.8	16.6	36.1	108.9	270.0	23.7
Digested from hay	270.1	263.7	6.8	15.2	85.	147.3	16.3
Digested from turnips	185.3	175.1	9.8	20.9	23.9	122.7	7.4
% digested from turnips	94.9	99.0	53.2	95.0	11.7	97.0	92.5

GLUTEN MEAL, CXXXIV.

Sheep 2.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed in hay, CXLI, daily	461.8	435.7	26.1	33.4	151.7	231.6	19.
Fed in gluten meal daily	269.4	266.4	3.	92.4	2.9	141.7	29.3
Total fed	731.2	702.1	29.1	125.8	154.6	873.3	48.3
Excreted daily	230.2	209.7	20.5	26.6	74.5	98.5	10.
Total digested	501.0	492.4	8.6	99.2	80.1	274.8	38.3
Digested from hay	272.9	262.3	10.4	15.8	83.1	149.8	13.2
Digested from gluten meal	228.1	230.1	......	83.4	......	125.0	25.1
% digested from gluten meal	84.7	86.3	......	90.2	......	88.2	85.6

Sheep 4.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed in hay, CXLI, daily	413.5	389.6	23.8	30.8	135.2	206.3	17.4
Fed in gluten meal daily	269.4	266.4	3.	92.4	2.9	141.7	29.3
Total fed	682.9	656.0	26.8	123.2	138.1	348.0	46.7
Excreted daily	195.4	176.5	18.9	32.0	54.3	82.	8.2
Total digested	487.5	479.5	7.9	91.2	83.8	266.	38.5
Digested from hay	244.4	234.5	9.4	14.5	74.1	133.5	12.1
Digested from gluten meal	243.1	245.0	......	76.7	9.7	132.5	26.4
% digested from gluten meal	90.2	91.9	......	83.0	33.4	93.5	90.1

Wheat Bran, CXXXV.

Sheep 1.

	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Fed in hay, CXLI, daily	461.8	435.7	26.1	33.4	151.7	231.6	19.0
Fed in wheat bran daily	264.8	246.8	18.	46.5	29.	156.	15.3
Total fed	726.6	682.5	44.1	79.9	180.7	387.6	34.3
Excreted daily	280.7	250.9	29.9	25.6	84.	129.1	12.
Total digested	445.9	431.6	14.2	54.3	96.7	258.5	22.3
Digested from hay	272.9	262.3	10.4	15.8	83.1	149.8	13.2
Digested from wheat bran	173.0	169.3	3.8	38.5	13.6	108.7	9.1
% digested from wheat bran	65.3	68.5	21.1	82.7	46.9	69.6	59.5
			Sheep 3.				
Total fed	726.6	682.5	44.1	79.9	180.7	387.6	34.3
Excreted daily	309.6	273.3	36.3	26.2	90.2	146.3	10.6
Total digested	417.0	409.2	7.8	53.7	90.5	241.3	23.7
Digested from hay	272.9	262.3	10.4	15.8	83.1	149.8	13.2
Digested from wheat bran	144.1	146.9	......	37.9	7.4	91.5	10.5
% digested from wheat bran	54.4	59.5	......	81.5	25.5	58.6	68.6

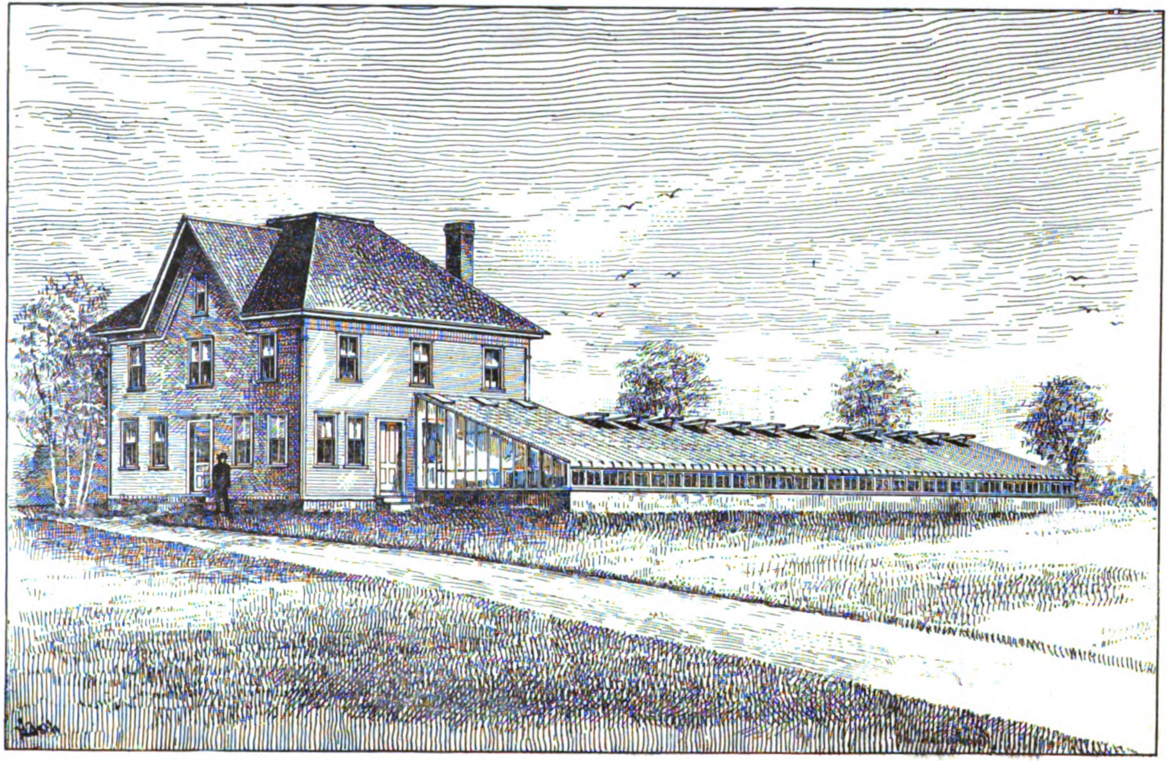

PLATE I. FORCING HOUSE, MAINE EXPERIMENT STATION.

REPORT OF THE HORTICULTURIST.

PROF. W. M. MUNSON.

As noted in the reports of the Experiment Station for 1889 and 1890, several varieties of orchard fruits and small fruits have been obtained by the Station, and some have been distributed to different parts of the state. Previous to the present year, however, there had been no organized department of horticulture, and as the work came under my charge in February, the past year has necessarily been largely taken up with pioneer work.

At the time the department came under the charge of the writer, a forcing-house, 20x100 feet, had just been completed. (See Plate I.). The house is well constructed. The frame work is of cypress, and the walls are of grout, while the building is heated by hot water. The house is divided in the center by a glass partition, and the hot water pipes have been so arranged that one part may be kept at a much lower temperature than the other. The warm house is arranged for bottom heat, and the cool house for over-head heat.

At the present time the warm house is used for tomatoes, cucumbers and beans; while the other is devoted to lettuce, radishes, cauliflowers and other plants requiring the lower temperature. Plate II is from a photograph of the interior of the cool house, as it appeared in December.

The building in connection with the forcing house, was erected during the year at a cost of about one thousand dollars, a part of the expense being borne by the college. The building contains, besides the furnace room and a room for the smaller garden tools, a general laboratory and work room, a small office, a room for herbarium work, and a well appointed photographic studio. In all of our work photography is made to play an important part as a means of preserving accurate records.

The grounds devoted to this division include about ten acres of land of varied character. More than half of this area is devoted to fruit culture. The apple orchard contains about 115 varieties, 52 of which are Russian varieties obtained from Professor Budd, of Iowa. There are also 23 varieties of pears, 30 of plums, 12 of cherries; also, quinces, 2 varieties; blackberries 9 varieties; raspberries 13 varieties; currants 7 varieties; gooseberries 3 varieties; strawberries 17 varieties. As the college campus is under the supervision of the writer, a considerable amount of experimental work is done with ornamental plants on other areas.

Variety testing, as such, either of fruits or vegetables, is not made a leading feature of our work. While we cultivate most of the novelties which promise well for the trying climate of the state, the more important part of our work is perennial, and has to do with the investigation of certain cultural problems, and of certain of the laws of plant variation. While it is designed to make the work practical, so far as possible, we must recognize the fact that any work to be of permanent value, must be based on sound principles. With this idea in mind, we are making a special study of the effects of climate on plant variation. We are also making an extensive study of the effects of pollination. Practical application of the principles involved, and of the facts learned, is made in our attempts to ameliorate certain of our native fruits, and to extend the list of fruits and vegetables which may be profitably grown in this region. Numerous crosses and hybridizations have been made and valuable results are indicated.

Our work with egg plants commenced two years ago, and the past season some two hundred plants, of the second generation from the crosses, were grown on our grounds. Selections have been made from the more promising of these, and the work will be continued and extended.

The forcing of vegetables under glass is made an important feature of our work. It is believed that from a practical point of view, this line of work is destined to become of great importance to the people of the state. While a study of methods of culture is made, and also of varieties suitable for forcing, at the same time, the material thus grown furnishes the best possible opportunity for conducting the work of crossing, as the conditions of growth are under control. We are now forcing tomatoes, cucumbers, beans, lettuce, radishes, cauliflowers and some others. Plate III is a view of the tomato house as it appeared about the first of January.

Recognizing the importance of the fruit industry of the state, and the necessity of combating the insect and fungous enemies which are proving a serious obstacle to success, experiment have been conducted during the year to determine the effectiveness of certain insecticides and fungicides. The results obtained are very encouraging and the work will be continued and extended during the ensuing year.

Attention is being given to the amelioration of our native fruits, and to developing the possibilities of fruit culture in the more trying localities of the State.

Following is given somewhat in detail a part of the work of the year. Some of the work being incomplete, the report will be made later.

THE VEGETABLE GARDEN.

Owing to the fact that the soil intended for vegetable gardening was badly infested with "witch grass," it was thought best to subdue the land before undertaking much work with vegetables. Our attention during the past season has been given chiefly to certain points in the culture of cabbages, tomatoes and egg plants.

I. NOTES OF CABBAGES.

Some twenty varieties of early cabbages were grown; the special design being to study the effect of different methods of culture, and to compare the relative merits of seed from the east, and from the extreme northwest, as well as to try some of the newer varieties not yet placed on the market.

1. *Culture:* In general, cabbages for early use should be started in hot beds or forcing houses from the first to the middle of April. To prevent crowding, transplant once or twice before setting in the open ground in May. If the plants are "hardened off," *i. e.* gradually exposed to lower temperatures, before being placed out of doors, they will stand a light frost without injury. Frequent cultivation is advisable.

2. *Influence of Transplanting:* It is a common practice among gardeners to handle certain vegetables from one to three or four times before setting in the open field; the object being to render the plants "stocky," and, it is thought, better able to withstand the shock of final removal to the field. The operation is also thought to hasten the maturity of the plants, and to increase the production of fruit. How far these impressions are correct, we are not as yet prepared to state. Some contend that this manipulation of the plants tends to dwarf them, thereby reducing the amount of fruit, or in case of cabbages, the size of the head.

It is the practice of the writer to handle cabbages, tomatoes and other vegetables started under glass, in pots, so far as possible. In this way the plants suffer little or no check in transplanting, and with some sorts at least, better results are obtained. Plants grown in boxes or flats, are necessarily mutilated each time they are handled.

To determine the extent of the influence of the different methods of treatment on the development of the cabbage, a portion of the plants were handled in pots and the remainder in flats till ready for the final transfer to the field. The plants handled in pots were removed from the seed-flats to 3-inch pots, and later to 4-inch pots. Those handled in boxes were placed about two inches apart at the first transplanting, and about four inches each way at the second. When put out in the field, all were placed in rows three feet apart, and two feet apart in the row.

Table I shows the results obtained.

TABLE I.

VARIETIES.	No. of heads.	Heaviest head. lbs.	Lightest head. lbs.	Av'ge weight. lbs.	No. of heads cracked.	No. of immature heads.	No. of plants not cut.	Ratio.	Remarks.
JERSEY WAKEFIELD. (Thorburn.)									Cut July 28.
Pots	25	3.0	1.0	1.8	2	2		1.38	
Boxes	24	2.0	.7	1.3	2	1	4	1.00	
JERSEY WAKEFIELD. (March.)									"
Pots	17	2.75	1.0	2.0	2	5	2	1.33	
Boxes	8	2.25	.75	1.5	1	2	2	1.00	
EARLY ETAMPES. (Thorburn.)									Cut Aug. 26
Pots	25	3.1	1.1	2.4	0	4		1.00	
Boxes	14	4.5	1.7	3.8	3	1		1.58	
BRUNSWICK. (Thorburn.)									"
Pots	14	7.4	3.0	5.0	0	0		1.22	
Boxes	11	5.9	2.1	4.1	0	0		1.00	
STEIN'S FLAT DUTCH. (Thorburn.)									"
Pots	18	11.9	6.4	8.1	6	0		1.00	
Boxes	15	11.7	5.5	9.1	1	0		1.11	

With three varieties, heads from the plants handled in boxes were lighter, and in two cases they were heavier than those from the pots. *Brunswick* averaged .9 lb. per head heavier from pot-grown plants, while *Flat Dutch* gave an equal difference in favor of the boxes.

Conclusion: From the results obtained, it appears that disturbing the roots in transplanting cabbages, has no marked effect on the size of the head or the time of maturity, if the plants are given good after treatment.

3. Influence of Deep and Shallow Setting, Combined with Other Treatments: It is commonly taught that cabbage plants should be set deeply; that long "leggy" plants will not produce good heads. From extensive trials at other experiment stations during the past two years, it has been pretty clearly shown that the practice of deep setting has not the importance commonly attached to it.† Having a few surplus plants, however, the question of deep and shallow planting was included with certain other cultural problems. The variety used was Jersey Wakefield.

Table II gives the results.

TABLE II.

HOW HANDLED.	Number cut.	Heaviest head. lbs.	Lightest head. lbs.	Av'ge weight. lbs.	No. of heads cracked.	No. of heads immature.	No. of plants not cut.	Remarks.
a.—Pots, deep, 3 times.......	17	2.75	1.00	2.00	2	5	2	
b.—Pots, shallow, 3 times ...	19	2.25	.75	1.58	2*	5	1	* Slightly.
c.—Box, deep, 3 times.......	8	2.25	.75	1.55	1	2*	2	"
d.—Box, deep, 2 times	13	2.50	1.00	1.50	2	1*	2	"
e.—Box, shallow, 3 times....	8	1.62	1.12	1.37	0	0	4	
f.—Box, shallow, 2 times....	13	2.00	1.00	1.29	1	1	0	

The first column in the table shows the number of times the plants were handled, and the manner of handling. "Deep" indicates that the plants were set up to the seed leaves at the first transplanting, and still deeper at each subsequent handling. "Shallow," indicates that the plants were set no deeper than they naturally grew in the seed flat. Seed was sown March 28. The plants transplanted three times were handled April 6, April 24, and May 19, when all were put out in the open field on clayey loam of only moderate fertility. Those transplanted twice were handled April 6 and May 19.

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† See Bulletins 15 and 25, Cornell University Experiment Static

A study of the table will show, first of all, that plants grown in pots and set deeply gave decidedly the best results. This method of treatment seems specially suited to the variety under discussion. In previous trials we have observed that Jersey Wakefield has usually given better results when set deeply.

It will also be observed that from the plants handled three times, the average weight of the heads was invariably greater than from those handled twice. It is probable that the reason for this lies in the fact that the actual mutilation was necessarily less, when the plants were handled more frequently,—the root system being less widely extended.

Conclusion: The heaviest heads were obtained by frequent transplanting and by setting the plants deeply. This may not be a general rule applying to all varieties.

Frequent transplanting increased the average size of the heads.

4. *Varieties:* A good cabbage has a short stem; leaves placed close together, and having short petioles, thus leaving little open space about the stem. The blade should be large enough to extend more than half way around the head to avoid the soft spot often seen in the center. The leaves should also embrace each other very firmly. Firm, solid heads are less subject to the attacks of the "cabbage worm," than are loose, open ones. This fact is of no small importance in selecting a variety.

Most of the varieties grown are well known, and require no special description. A few may be mentioned, however, to direct the attention of planters to the more valuable ones for the home garden.

Jersey Wakefield. Small, conical, firm. The best of the very early varieties. This old variety, though popular for many years with market gardeners, is too often unknown in the average home garden.

Brunswick (Fottler's.) Medium size, depressed, very firm. Leaves closely set on the stem; blade well developed, second early. One of the best.

Early Summer: Medium size, nearly spherical, firm. About ten days later than Jersey Wakefield. Good.

Early York: Medium size, loose, open. Should have been discarded long ago.

Flat Dutch: Large, flattened, solid. A standard late variety.

Two new varieties were sent for trial by Francis Brill, Hempstead, N. Y. The names given both varieties, "Nonesuch" and "Worldbeater," are objectionable and would tend to make planters hesitate before selecting them.

Nonesuch: Light colored, very glaucus. Heads of medium size, flattened, resembling Early Summer. Stems short; leaves closely set, and well developed. Early. Worthy of further trial.

Worldbeater: Light colored. Head of medium size, spherical or oblong. Leaves much cut and wrinkled; not closely set on stem; petiole long.

SUMMARY.

1. Disturbing the roots of cabbage in transplanting, appears to have no marked effect on the size of the head.

2. The best results were obtained by frequent transplanting.

3. In general, depth of setting seems to have little influence on the size of the heads; but Jersey Wakefield gave better results from deep setting.

4. Firmness is an important characteristic of a good cabbage, as such heads are less injured by attacks of the cabbage worm.

5. Of the older varieties, Jersey Wakefield, Brunswick, Early Summer, and Flat Dutch are good for general culture; Early York should be discarded.

6. Of the newer varieties tested, Nonesuch is promising.

II. NOTES OF TOMATOES.

1. *Culture:* One of the important problems in tomato culture for the state of Maine, is that of securing *earliness*. As a rule, plants purchased of the local dealers are drawn and "leggy," being crowded together in small boxes. When set in the field the shock is such that several weeks are required for the plants to recuperate; consequently no fruit sets till late in the season, and the larger portion of the crop is still unripe when the vines are killed by frost. In general, these weak, drawn plants are not worth setting.

Frequent "handling" or transplanting, is found to be the best method of securing strong, stocky, well developed plants. Some of the best cultivators combat this idea, but in our own experience the transplanting has been found beneficial. The practice of the writer is to sow the seed in "flats,"—shallow boxes about 16 by 24 inches and 3 inches deep—about the first of April. When the first true leaves have nicely started, or as soon as the plants begin to crowd, they are transferred to 2-inch rose pots. As the pots are so small, we usually plunge them in sphagnum to prevent too great extremes of moisture. As soon as the pots are well filled with roots—usually in two or three weeks—the plants are re-potted into 3-inch or 3 1-2-inch pots. Later they are again handled into 4-inch pots and given an abundance of room; being finally transferred to the open ground, from the first to the middle of June. If short of pots, we sometimes handle the plants in flats until they are ready for the final transfer. In this case they are usually placed about two inches apart each way at the first handling, and four or five at the second. By this treatment the roots are confined to a comparatively small space, and the plants suffer less severely when planted out. The plants are set in the field in rows five feet apart each way, and the horse cultivator is used freely.

2. *Effect of Early Setting:* It is commonly held that tomato plants should not be set out in the field till the cool nights of early summer are past—certainly not before the middle of June. The results of an experiment conducted last year, however, indicated that earlier setting was at least not detrimental, and might be beneficial.*

To test the matter further, fifteen plants of Perfection, as nearly alike as possible, were selected and given the same treatment while in the house. Five plants were set in the field on sandy loam having a southern aspect, May 18. Five more were placed by the side of these May 30, and the other five were set next to them June 8, when the main crop was planted out. Plants set May 18 and May 30 were injured by frost May 31.

The results were as follows:

	a. May 8.	*b.* May 30.	*c.* June 8.
Average number fruits per plant	47.0	33.0	20.0
Average weight of product, in pounds....	16.1	12.4	6.9
Average weight per fruit, in ounces.......	5.4	5.9	5.6

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* Bulletin XXI Cornell University Experiment Station.

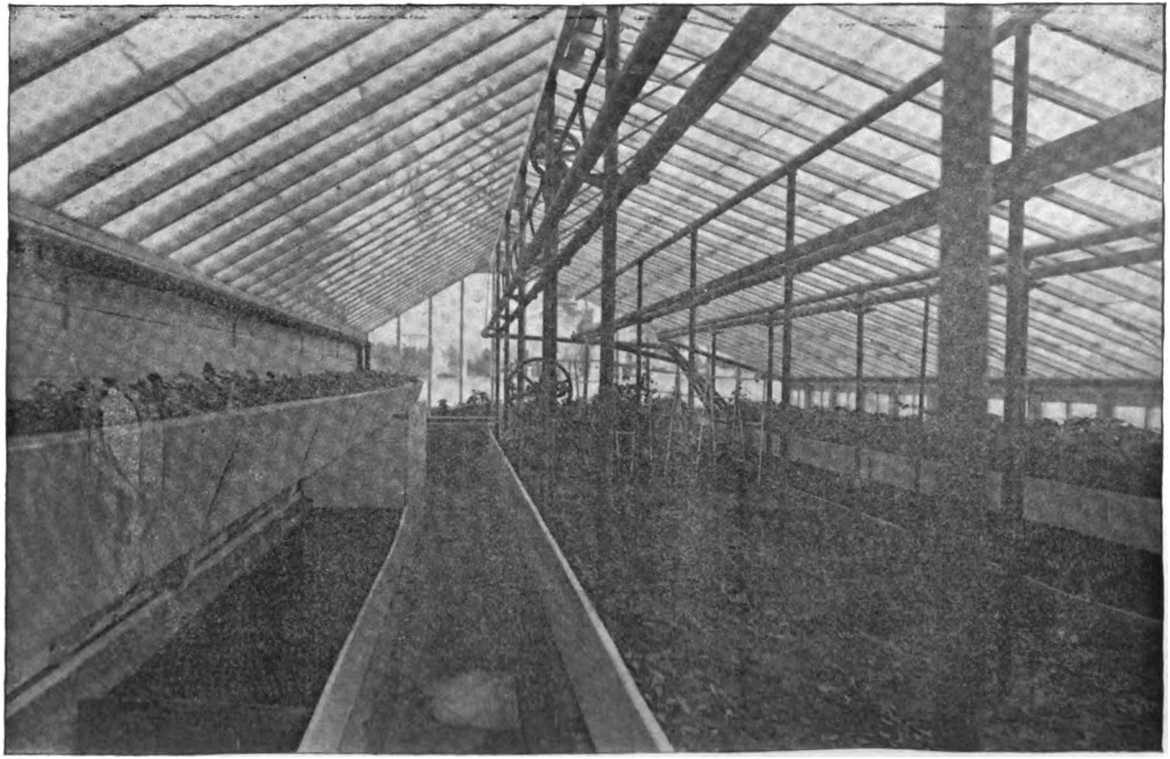

PLATE II. INTERIOR OF COOL HOUSE.

The total average product was in direct proportion to the earliness of setting. The relative earliness was also observed to follow the same order.

The total product of the five plants for the month of August was respectively:

	Number of fruits.	Weight. lbs.
a	31	8.5
b	25	7.4
c	14	4.2

The season was exceptionally long, but even so late as September 30, the earlier plants maintained their superiority. The last two pickings, Sept. 26 and 30, gave the following results:

	Number of fruits.	Weight. lbs.
a	163	57
b	118	[illegible]
c	67	23

Conclusions: On warm, sandy soil, the earliness and productiveness of tomatoes was in direct ratio to the earliness of setting in the field.

A chill, and even a slight cutting by frost is not as fatal to success as is commonly supposed.

It is well, in practice, to set some plants in the field early in the season, holding others in reserve to replace the first if killed by frost.

3. *Effects of Trimming Tomatoes:* With a view to applying the principle that "checking growth induces fruitfulness," to the culture of tomatoes, several varieties were operated upon in 1890. The results, as a rule, indicated that trimming the vines is a profitable method of inducing earliness, and consequently of increasing the portion of the crop available. The total increase in the number of fruits ranged from 5.5 per cent. to 47.6 per cent.

During the past season the trial was repeated. Plants of *Perfection* and *Chemin Market* were used in the test. Twelve plants of the former and five of the latter were headed back July 24, Aug. 8, and Sept. 5. At each trimming the leading branches were shortened about six inches, and most of the side shoots below the first clusters of fruit were removed, the others being shortened. The sunlight was thus freely admitted to the fruit, and picking was rendered much easier. The following figures are significant.

	Average No. fruits per plant, ripened Sept. 30.	Average weight of product in lbs.	Average weight of individual fruits, in ounces.	Per cent. gain by number.	Per cent. gain by weight.
*PERFECTION.					
Trimmed	45	17.1	6.1	36.3	44.0
Not trimmed	33	11.8	5.6		
CHEMIN.					
Trimmed	12	3.8	4.9	50.0	58.3
Not trimmed	8	2.4	5.0		

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* A portion of the Perfection plants used in this test were set out in May, hence the two varieties should not be compared in this case.

The average number of fruits, and also the weight of the product was materially increased by trimming the vines. The size of individual fruits was increased in one case, but in the other there was a slight decrease.

Conclusions: Trimming tomato vines hastens maturity of the fruit, and consequently increases the portion of the crop which is available, or the apparent yield of the plants.

As the time required for the work is small, the practice will doubless be a good one for amateurs.

4. *Color of Fruit:* Numerous attempts have been made to improve upon the color of the fruit of the tomato. As the color is quite variable, and as the yellow varieties are sports from the red, it has been thought possible to secure a yellow fruit with a blush cheek. With this purpose in view, numerous crosses have been made between red and yellow varieties. In 1890, several successful crosses were made by Mr. C. W. Matthews of Cornell University, and seeds from one of these, in which Golden Queen was used as the pistillate parent and Ignotum as the male, were grown by the writer during the past season. The plants were very vigorous and productive, but failed to show any trace of the influence of the female parent. The fruit was in every way, as to form, color and size, typical of the true Ignotum. Similar results were obtained by Professor Bailey at the Cornell Experiment Station.

Observing a slight tendency on the part of Golden Queen, to vary in the desired direction, a selection was made in 1890. The past season the tendency was much more marked, and some very handsome fruits resulted. If the color can be fixed, the desired end will have been accomplished. It seems probable, however, that selection in this direction will cause a reversion of the form to the red type, as red is the normal color of the species.

5. *Varieties*. It has not been deemed advisable to grow a large number of varieties; but rather, to select the best of the older, well known sorts, and such new ones as may appear from time to time. Earliness is one of the principal measures of value for any variety in this climate, and many valuable sorts must be discarded because they are not early. I am aware that some contend that there is practically no difference in earliness, but the fact remains, and we must shape our course accordingly. Owing to the unusually long season, all varieties ripened some fruit during the past year.

Beauty. (Livingston).—Of medium size, bright pink, smooth, uniform, prolific. A well tried and valuable sort.

Chemin Market. (Cornell University, Vaughan).—Small to medium, bright red, smooth, prolific; uniform in size and shape, somewhat resembling Hathaway. Possibly too late, but worthy of further trial.

Cleveland. (*President Cleveland*, Farquhar).—Small, red, corrugated about the base. Plant vigorous, but only moderately productive.

Favorite. (Livingston).—Of good size, bright red, smooth. As usually grown, a deservedly popular variety. The strain grown this year was not equal to that grown before, however.

Faultless. (*Faultless Early*, Farquhar).—Small, early, bright red, flattened or indented at apex. Early fruits very irregular; later ones better. Plant of medium size, productive, matures early.

Golden Queen. (Cornell University, Livingston).—Of medium size, spherical, smooth, clear golden yellow with occasionally a blush cheek; early, prolific. The best yellow tomato, and a valuable sort for the home garden.

Ignotum. (Cornell University).—Large, smooth, deep red, firm and meaty, with few seeds; early and productive. This variety originated at the Michigan Agricultural College, and has been on the market only two or three years. From well selected stock it easily ranks at the head of the red tomatoes.

Ithaca. (Cornell University).—Small to medium, light cherry, firm, smooth, of good quality, but appears to possess no characteristics which render it more valuable for field culture than some of the older varieties. The variety is a local one grown by gardeners in the vicinity of Ithaca, N. Y., for many years. It is not yet catalogued by any of the seedsmen. We have the variety growing in the house at the present time, and are very much pleased with it as a forcing variety.

Long Keeper. (Thorburn).—Of medium size, light purple, smooth, symmetrical, ripens evenly without tendency to rot. Promising.

Lorillard. (Cornell University).—Of medium size, nearly spherical, bright red, smooth, fairly productive. The special value of this variety is as a forcing tomato. For this purpose it is one of the best.

Mitchell. (Gregory).—Small to medium, inclined to be irregular, bright red. A rampant grower.

Peach. (Thorburn).—Small, purple, very prolific; soft but keeps well. Unlike any other tomato, this variety has a rough skin and when just maturing the resemblance to a peach is quite noticable. Valuable for amateurs.

Potomac. (Harris).—Of the Acme type; large, purple, corrugated about the stem, soft.

Prelude. (Thorburn).—Small, nearly spherical, smooth, uniform, early, very prolific. Valuable for the amateur.

Red Cross. (Farquhar).—Of medium size, smooth, bright red.

Ruby. (Henderson).—Small, red, inclined to be angular. Plant of weak habit. Not as satisfactory as in 1890.

Stone. (Livingston).—Medium to large, smooth, regular, bright scarlet, productive. Promising.

The varieties which appear to us most valuable for general culture are, Ignotum, Perfection, Beauty and Golden Queen, with the possible addition of Prelude for the home garden.

Of the newer varieties, Long Keeper and Stone are promising. Ruby does not hold its own. Ithaca is a promising variety for forcing.

SUMMARY.

1. An important requisite to successful tomato culture is that the plants be kept growing vigorously; a condition involving rich soil and frequent tillage.

2. Frequent transplanting makes stocky plants.

3. Plants are not checked as much as is commonly supposed, by the cool nights of early spring.

4. Other things being equal, the earliness and productiveness of tomatoes is in direct proportion to the earliness of setting in the field.

5. Trimming the plants after a part of the fruit had set, increased the yield by more than one-third.

6. The best varieties for general use appear to be Ignotum, Perfection, Beauty, Golden Queen, and possibly Prelude for home use.

7. Of the new varieties, Long Keeper and Stone are most promising.

III. NOTES OF EGG PLANTS.

As already noted, we are making the egg plant a subject of special study. A full report in regard to this work is reserved till a later date, however.

Egg plants delight in a warm, moist climate, rich but light soil, and constant cultivation. While they reach the highest state of perfection in warmer climates, and near the coast, by careful treatment they may be grown over a large extent of country. In this climate they should be started as early as the first of April, in a hot bed or forcing-house, and should be kept growing vigorously till about the middle of June, when they may be removed to the open field. They should be placed in rows about three feet apart to permit the use of a horse in cultivating.

Frequent and thorough cultivation is a prime requisite to success. We make a practice of going through the plantation at least once a week with a Planet Jr. cultivator, and make free use of the hoe as well.

Of the varieties commonly catalogued, *Early Long Purple* and *Early Dwarf Purple* will doubtless prove most satisfactory in this climate. The larger and later sorts will hardly begin to develop fruit before the early frosts. There is reason to believe, however, that valuable results may be obtained by crossing these early, prolific varieties with some of the larger sorts. From crosses we now have growing, more satisfactory results were obtained during the past season, than from any of the older fixed varieties.

FRUIT TESTS.

The Experiment Station is not situated within the section of the state best adapted to fruit culture. Being on the flat bottom lands in the valley of the Penobscot, conditions of soil and climate are different, and somewhat more trying than in other portions of the state. This fact has its advantage, however, as varieties which prove hardy at Orono will probably succeed in any of the southern counties of the state.

The scope of the work already in progress has been indicated in a general way in the annual reports of the Experiment Station for 1889 and 1890. At the beginning of the present year, when the orchard came under the care of the writer, the trees were in a very bad condition from the effects of the severe winter.

The winter of 1890-1 was one of the coldest known for twenty years; the mercury on one occasion reaching —36.3°, while the mean temperature for December was 12.2° Fahr. The fruit plantation is on warm, rich soil, and the trees failed to mature the new growth. Consequently, trees which should prove hardy in our climate were either killed or severely checked. The loss was specially marked in case of pears and plums.

An all important requisite of hardiness is that the wood complete its growth early in the season, and become well matured before cold weather approaches. Hardiness is therefore only relative, and may in a measure be controlled by the cultivator. Orchards and fruit plantations generally, should not be cultivated after the first of August, till growth is checked by heavy frost.

The following field notes indicate in a general way the condition of the orchard at the beginning of the year, and the relative hardiness of different varieties:

PEARS

Angouléme	Killed.
Anjou	Considerably injured.
Bartlett	Top killed. Sprouts above graft.
Clairgeau	One killed outright. The others, top killed, but sprouts appear.
Clapp's Favorite	In good condition.
Flemish Beauty	“ “ “

Hardy	One killed, the other injured.
Howell	Slightly checked. Starts well.
Josephine de Malines	One killed to the roots; the others badly injured.
Keiffer	Killed.
Lawrence	Slightly injured.
Le Conte	Killed.
Louise Bonne	Top killed. Sprouts above graft.
Seckel	Killed.
Sheldon	In good condition.
Souv. du Congres	One killed; the others badly injured.
Superfine	Considerably injured.
Winter Nellis	Slightly checked; starts well.

Plums.

Blue Damson	One killed outright. The others top killed.
Bradshaw	Uninjured; not vigorous.
Duane Purple	Uninjured.
Gen. Hand	All but one dead; this, badly checked, but starts well.
German Prune	Uninjured.
Golden Drop, (Coe's)	Checked, but starts vigorously.
Imperial Gage	All but one killed; this badly injured.
Jefferson	One killed, the others badly checked.
Lombard	Very badly injured. Had made remarkably strong growth the previous season.
Moore's Arctic	Uninjured.
Pond's Seedling	One killed, the other badly checked.
Quackenbos	Uninjured.
Reine Claude	One killed; the others badly injured.
Simons' (Prunus Simoni.)	“ “ “ “ “
Smith's Orleans	“ “ “ “ “
Washington	“ “ “ slightly “
Weaver	Badly checked, but starts vigorously.
Wild Goose	Killed.
Yellow Egg	Uninjured.

Cherries.

Of the eight varieties of cherries, but one, Gov. Wood, was seriously checked, and this one made a good growth during the past season. Part of the varieties were protected, however, by means of a cedar hedge on the northwest.

The data are interesting, as showing the condition of the experimental orchard after the first hard winter, and as exhibiting unexpected variations in hardiness. Of the pears, those least injured by the winter were: Clapp's Favorite, Flemish Beauty, Howell, Lawrence, Sheldon, and Winter Nellis. Of plums, the most hardy appear to be: Bradshaw, Duane Purple, German Prune, Moore's Arctic, Quackenbos, Washington, and Yellow Egg. The injury to Lombard, one of our hardiest varieties, is in accordance with the statement before made, that hardiness is only a relative condition. This variety, because of its vigorous, watery growth, failed to mature the wood and suffered accordingly.

During the past year the orchard has been largely extended and the trees have made a vigorous growth. Several of the newer varieties of apples and pears, as well as some older ones not common in this region, have been added to the collection. Several varieties of plums, cherries and quinces have also been added.

Small fruits are also receiving due attention. The climate of the state is such that cultivators may take advantage of the natural conditions of the markets, and with suitable varieties, make the culture of small fruits a very profitable industry. The fruit may be put upon the market at a season when there is little competition from other sources, and when the best fruit will command high prices. We are endeavoring to determine the best of the hardy varieties now before the public, and to secure by means of selection and crossing, new varieties specially adapted to the climate, and to the demands of the natural markets of the state.

During the year, the following varieties have been added to the collection of small fruits. (The list of varieties before planted was published in the annual reports for 1889 and 1890.)

Blackberries: Agawam, Ancient Briton, Early Cluster, Stone (Stone's Hardy).

Raspberries: Hansell, Marlboro, Turner, Tyler, Johnston (Johnston's Sweet).

Currant: Prince Albert, La Versaillais.

Gooseberries: Whitesmith, Downing.

No part of the state is better adapted for the general operations of agriculture than is Aroostook County. The winters are so severe, however, that fruit culture has heretofore received little attention. Until the advent of the Duchess and the Wealthy, all attempts at apple culture resulted in disappointment. It is but few years since the positive assertion was made, that fruit culture is impossible north of the latitude of Houlton, (46° 10').

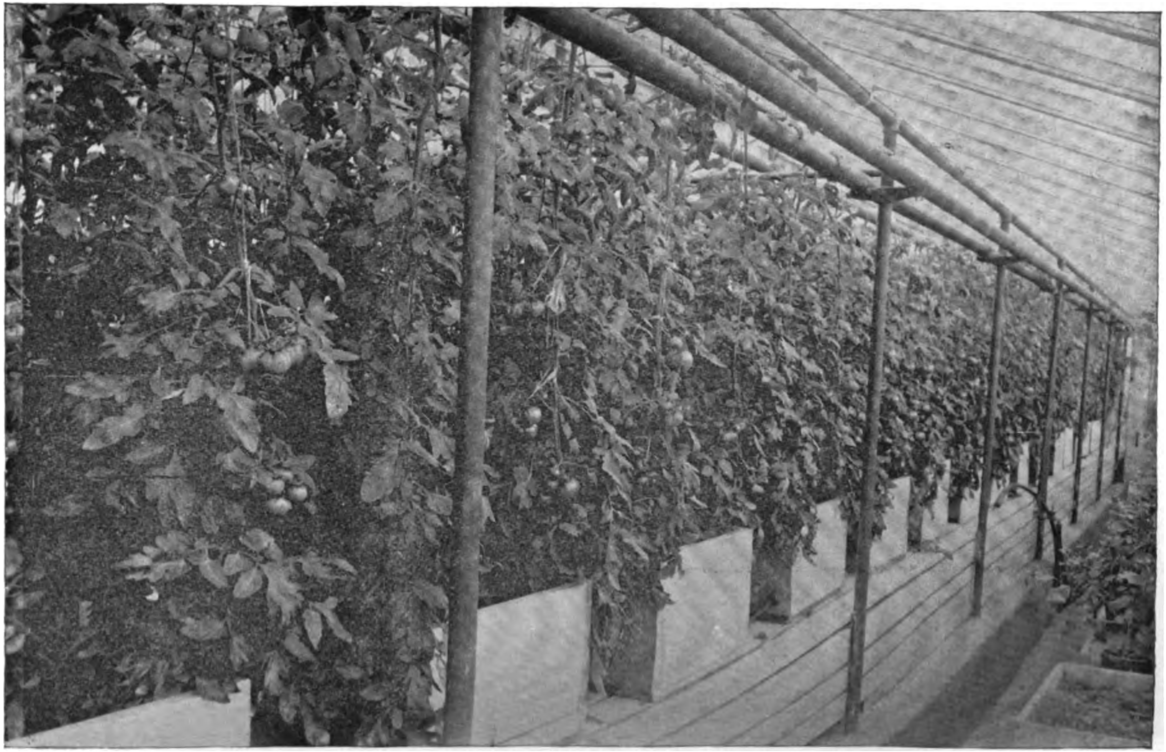


PLATE III. GROWING TOMATOES UNDER GLASS.

By steady perseverance on the part of a few enterprising planters, however, there are now thriving orchards in the latitude of Presque Isle and Caribou, and even as far north as Fort Kent, on the extreme northern boundary of the state.

The range of varieties is very limited in this northern region, however; the standard of hardiness being the Duchess and the Wealthy. Some valuable seedlings of these varieties have been produced and the number is gradually being increased. Dudley's Winter, a seedling of Duchess, is of much promise and is being extensively propagated. The variety originated with Mr. J. W. Dudley of Castle Hill Plantation.

In the hope of extending the list of apples and other fruits which may be grown in the more rigorous portions of the state, arrangements have been made with Mr. James Nutting of Perham, who has perhaps the largest orchard in northern Aroostook, to test certain varieties sent him and report to this department from time to time.

In April of the present year, cions of the following varieties of apples were sent to Mr. Nutting: Severs, Iowa Blush, McMahon, and Harry Kaump, from the U. S. Department of Agriculture.

Peach of Montreal, Prolific Sweeting, Longfield, Titus, Bethel of Vermont, Yellow Transparent, and Shiawassee Beauty, from Dr. T. H. Hoskins of Newport, Vermont.

"Sally" and Sweet Seedling, two seedlings of promise, from D. H. Knowlton, of Farmington, Me.

A few cions of Shiawassee Beauty were also sent from the college orchard for comparison with those from northern Vermont.

In addition to the apples, cions of the Hawkeye plum were sent, and grafted in the native Canada plum, *(Prunus Americana)*. Part of the apple cions were set in bearing trees, Duchess, and part in Duchess seedlings, one year stock.

The following is Mr. Nutting's report concerning the first year's growth:

Cions set in bearing trees: The trees are about twelve years old and being set 12x12 feet, are somewhat crowded. The cions, except those from Vermont, and the seedlings, were not in good condition, growth having commenced in most instances.

GROWTH OF CIONS IN BEARING TREES.

Variety.	Where obtained.	Number cions set.	Number cions living.	Average growth in inches.	Date of setting.
Harry Kaump	Dept. of Ag.	4	3	6	May 14.
Iowa Blush	" "	6	6	8	"
McMahon	" "	4	2	5	"
Severs	" "	6	3	5	"
Sally	Knowlton.	5	5	5	"
Sweet Seedling	"	2	2	20	"
Bethel of Vermont	Hoskins.	6	6	11	"
Longfield	"	6	5	6	"
Prolific Sweeting	"	6	6	6	"
Titus	"	4	2	18	"
Shiawassee Beauty	"	6	5	12	"
Shiawassee Beauty	College.	5	3	11	"

Cions set on seedling stock: Saddle or splice grafts were made on one year seedling stocks, and they were planted out the same day.

Variety.	Where obtained.	Number cions set.	Number cions living.	Average growth in inches.	Date of setting.
Iowa Blush	Dept. of Ag.	8	3	14	May 16.
McMahon	" "	3	0		"
Severs	" "	6	1	12	"
Bethel of Vt	Hoskins.	6	6	24	"
Longfield	"	2	2	12	"
Prolific Sweeting.	"	5	5	12	"
Shiawassee B.	"	7	3	14	"
Titus	"	4	4	12	"
Sally	Knowlton.	5	3	18	"
Sweet Seedling	"	2	1	20	"

The season was very dry and bad for nursery stock. All of the young trees were taken up November 12, and healed in for the winter.

The above report is given, not as indicating valuable results obtained, but as showing in a general way the work commenced in the "cold northeast." The deep snows constitute a serious obstacle to successful nursery culture during the first year or so. It is for this reason that the trees were taken up the first winter.

During the coming year the list of varieties under trial will be materially increased, and the culture of certain small fruits undertaken. The conditions of soil and climate seem specially adapted to the growth of currants and gooseberries. The only plum which has as yet proved satisfactory in northern Aroostook, is Moore's Arctic, which originated at Ashland in that section. Even this variety requires laying down each fall.

The native "Canada plum," *Prunus Americana*, is very variable in its character, and the region in question is specially rich in promising types of this species. Several selections of the more promising forms have been made, and it is hoped by careful selection and culture, valuable "iron-clad" varieties may be obtained.

Trees and cions of Rollingstone and Hawkeye plums were procured last spring, and others of the hardy native varieties from the northwest, as well as some of the better Russian sorts, will be introduced next season.

EXPERIMENTS IN SPRAYING.

The great and increasing importance of the fruit interests of the state seem to demand special attention on the part of the Experiment Station, and as the depredations of the insect and fungous enemies of the orchard are becoming more and more severe year by year, it has been decided best to do all in our power to combat these pests.

In other states it has been shown, apparently beyond question, that at least some of these orchard pests may easily be held in check. While it is not to be supposed that conditions of soil or climate would render the work of other experiment stations of no value in Maine, it has been thought best to prove for ourselves, and to the satisfaction of the people of the state, the effectiveness of certain remedies, if they are effective. In the reports of this Station for 1889 and 1890, Professor Harvey urged the use of certain insecticides and fungicides and gave full directions for applying, with descriptions and cuts of various kinds of spraying apparatus. Heretofore, however, no field work has been undertaken by the Experiment Station. By mutual understanding this work has been placed in the hands of the writer.

Owing to the fact that the orchard belonging to the Experiment Station is not of bearing age, and that there are no large orchards in the vicinity of the college, the work has necessarily been at a disadvantage. It was necessary to go to Kennebec county to find suitable orchards which were available. Much credit is due to the parties who have given the use of their orchards and have so faithfully assisted in the work. Special credit is due Messrs. Charles S. Pope of Manchester, W. P. Atherton of Hallowell, C. E. Moore and F. M. Woodward of Winthrop. These gentlemen all gave their time freely, and their intelligent assistance is appreciated.

There were two main objects in the field work of the present season: *first*, to combat the codling moth; and *second* to prevent, if possible, the ravages of the apple scab.

I. Codling Moth, (*Carpocapsa pomonella*).

For a number of years several prominent experimenters and many progressive orchardists, have advocated the use of the arsenites, Paris green or London purple, to hold this pest in check. The experiments of Cook, Goff, Gillette and others would seem to leave little doubt as to the value of this treatment. However, for our own satisfaction, and to bring the matter more forcibly before the people of the state, the following work was undertaken:

1. *Is Spraying with Paris Green an Effective Remedy?* The first question asked by an orchardist, regarding any remedy or preventive, is: Does it prove effective? To answer this question, trees were sprayed in the orchards of Messrs. W. P. Atherton, of Hallowell; Charles S. Pope, of Manchester, and C. E. Moore of Winthrop.

In Mr. Atherton's orchard, a row of Rhode Island Greenings, and a row of Hubbardston Nonesuch were selected for the trial. Four Greening trees were sprayed with Paris green in the proportion of 1 pound to 250 gallons of water; an equal number received 1 pound to 300 gallons; and three trees were left unsprayed as checks. Of the Hubbardstons, one tree was sprayed with the mixture of 1 pound to 250 gallons; two, in the proportion of 1 pound to 300 gallons, and two were left unsprayed.

Two applications were made. The first one, June 11, just as the last blossoms were falling, was under the personal supervision of the writer. The second was made by Mr. Atherton two weeks later. The weather was hot and dry at the time of each application.

The fruit was gathered October 3d. With the help at command it was found impracticable to pick and count the fruit from all of the trees. Therefore, in case of the Greenings, two trees of each lot were taken, reference being given to the relative size and productiveness of the trees, so far as possible. All of the fruit was picked from the trees, and all that had fallen was gathered separately.

Table IV indicates the comparative results.

TABLE IV—Rhode Island Greening.

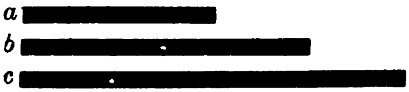
Treatment.	Nature of fruit.	Whole number of fruits.	Number wormy.	Per ct. wormy.	Average per ct. wormy.
1 lb. to 250 gals.....	1st tree:				
	Picked	453	9		
	Fallen.......	67	18		
	TOTAL.....	**520**	**57**	**10.96**	
	2nd tree:				
	Picked	727	25		**7.14**
	Fallen	98	14		
	TOTAL.....	**825**	**39**	**4.72**	
1 lb. to 300 gals.....	1st tree:				
	Picked	1069	101		
	Fallen	165	53		
	TOTAL.....	**1234**	**154**	**12.48**	
	2nd tree:				
	Picked	1100	47		**10.08**
	Fallen	145	49		
	TOTAL.....	**1245**	**96**	**7.71**	
Not sprayed........	1st tree:				
	Picked	1195	124		
	Fallen	228	114		
	TOTAL.....	**1423**	**238**	**16.02**	
	2nd tree:				
	Picked	556	73		**20.11**
	Fallen	253	138		
	TOTAL.....	**809**	**211**	**26.08**	

TABLE IV (Continued.)—HUBBARDSTON.

Treatment.	Nature of fruit.	Whole number of fruits.	Number wormy.	Per ct. wormy.	Average per ct. wormy.
1 lb. to 250 gals.	Picked	773	13		
	Fallen	36	28		
	TOTAL	**809**	**41**	**5.06**	**5.06**
1 lb. to 300 gals.	1st tree:				**10.04**
	Picked	681	11		
	Fallen	33	22		
	TOTAL	**714**	**33**	**4.62**	
	2nd tree:				
	Picked	836	75		
	Fallen	83	56		
	TOTAL	**919**	**131**	**14.25**	
Not sprayed.	Picked	652	145		
	Fallen	169	122		
	TOTAL	**821**	**267**	**32.52**	**32.52**

While none of the trees were as severely attacked as is the case some years, there was a marked difference between the sprayed and the unsprayed trees. The unsprayed Greening trees had an average of about 20 per cent. of wormy fruit; while in no case was there more than 12.5 per cent. on the sprayed trees, and in most instances the percentage was much lower. With the Hubbardstons the difference was fully as marked; the percentage of wormy fruit on the unsprayed trees being 32.5, while the highest percentage from a sprayed tree, the weaker solution being used, was but 14.25

By observing column five in the table, it will be seen that the percentage of wormy fruits is much less when the stronger mixture was used. By the use of the weaker mixture, nearly one-half, (49.8 per cent.), of the loss was prevented, while by the use of the stronger mixture the amount of wormy fruit was reduced by 64.5 per cent. The figure gives a graphic representation of the relative amount of wormy fruit under the different treatments; letting *a* represent the average amount of wormy fruit on the trees sprayed with the stronger mixture; *b* the weaker mixture and *c* the unsprayed trees.



In addition to the work above detailed, several Greening trees in another orchard some distance from the first were sprayed with

Paris green in the proportion of 1 pound to 250 gallons water. Two applications were made as in the other orchard. In getting data from this orchard, three hundred fruits were taken indiscriminately from all parts of each tree. The percentage of wormy fruits thus obtained, while not absolutely final, may be regarded as a fair basis for comparison. The trees were in parallel rows, thirty feet apart.

The following figures indicate the comparative results:

	SPRAYED.			NOT SPRAYED.		
	Number of fruits.	Number wormy.	Per cent. wormy.	Number of fruits.	Number wormy.	Per cent. wormy.
1st tree	300	44	14.7	200	74	37.
2nd tree	300	40	13.3	300	113	37.7
3d tree	300	20	6.7	300	85	28.3

As will be seen, more than one-third (34 per cent.), of the fruit on the unsprayed trees was wormy; while on the sprayed trees, only one-ninth (11.5 per cent.), was wormy.

In other words, spraying the trees twice with Paris green reduced the number of wormy fruits by 66.3 per cent. and saved more than one-fifth, (22.5 per cent.), of the total crop.

Results in Mr. Pope's Orchard.

In order that we might have as many checks on our work as possible, an arrangement was made with Mr. Charles S. Pope, of Manchester, to spray a portion of his orchard with Paris green. But one application was made, June 25, when the fruits were about the size of acorns.

The results obtained are given in table V.

TABLE V.

Variety and treatment.	Sprayed.				Not Sprayed.				Ratio of sprayed to unsprayed trees.	Remarks.
	Whole number of fruits.	Free.	Wormy.	Per cent. wormy.	Whole number of fruits.	Free.	Wormy.	Per cent. wormy.		
Talman (1 lb. to 320 gal.)	344	274	70	20.3	392	226	166	42.3	1:2.07	All fruits picked from trees and all from ground that had fallen in 2 w'ks.
	397	308	89	22.4	681	371	310	45.5		
Baldwin (1 lb. to 240 gal.)	451	403	48	10.6	431	338	93	21.6	1:1.61	About 2½ bu. from all parts of each tree
	409	349	60	14.6	462	374	88	19.0		

The figures for each variety must be considered independently, as the trees were not in adjacent parts of the orchard. It will be seen, however, that in both instances there is a marked difference in favor of the sprayed trees.

The percentage of wormy fruit on both sprayed and unsprayed trees was much greater in case of the Talmans than with the Baldwins. A study of the table will show, however, that the actual increase of the sprayed over the unsprayed trees, in the amount of good fruit, was even greater in the first case. The figures are of value as showing the beneficial effects of even a single application of a dilute mixture.

As indicated in the last column of the table the ratio between the sprayed and unsprayed Talman trees is 1:2.07. In other words, if in a barrel of fruit from the sprayed trees there were 100 wormy fruits, there would be 207 wormy fruits in a barrel from the unsprayed trees. In the same way for every 100 wormy fruits on the Baldwin trees which were sprayed, there would be 161 on the trees not sprayed.

2. *Relative Number of Windfalls on Sprayed and Unsprayed Trees.* Observing that the number of fallen fruits was much greater under the unsprayed trees, a record was kept showing the absolute difference.

In case of the Greenings (see Table IV) sprayed with 1 pound to 250 gallons, 1 pound to 300 gallons, and unsprayed, the average amounts were respectively, 12.5, 12.3, and 21.5 per cent. of the total crop. With the Hubbardstons the difference was even more marked, the percentages being respectively 4.45, 10.04, and 20.58.

The owner of the orchard not being ready to harvest his Baldwins, and it being impracticable for the writer to make another visit to this orchard, a count was made of the actual number of windfalls under sprayed and unsprayed Baldwin trees at that date, October 4. An examination of three trees each, as nearly alike as possible, gave the following as the *average* results.

	Whole number of fruits.	Number wormy.	Per cent. wormy.
Sprayed,	144	55	38.2
Not Sprayed,	268	222	82.8

The absolute number of windfalls in case of the unsprayed trees exceeded that from the sprayed trees by 53.7 per cent., while the relative number of wormy fruits was correspondingly large, the difference in the average being 44.6 per cent. The figures plainly indicate that the actual number of fallen fruits is less from trees sprayed with Paris green, also that the percentage of wormy fruits among the windfalls is smaller from the sprayed trees.

3. *Negative Results.* Incidental to some other experiments, a few trees in an orchard belonging to F. M. Woodward, of Winthrop, were sprayed with Paris green. The work was conducted by Mr. C. E. Moore.

When spraying for the apple scab, certain trees were sprayed once with a mixture of Paris green and carbonate of copper in suspension. The poison was used in the proportion of 1 pound to 160 gallons of water. The trees were old, and were surrounded by unsprayed trees.

About three bushels of fruit were counted from each of four trees, care being taken to obtain fruit from all parts of the tree.

The results were as follows:

SPRAYED.			NOT SPRAYED.		
Perfect.	Wormy.	Per cent. wormy.	Perfect.	Wormy.	Per cent. wormy.
387	93	19.3	480	75	13.5
218	86	28.2	394	159	28.5

The results are indifferent or negative. The conditions were such, however, that little reliance is placed on this test.

4. *Point of Attack.* The objection has been raised by some of our fruit growers that a large proportion of the affected fruit is entered from side or base, and consequently that spraying before the fruit turns down has no special merit. Special attention was accordingly directed to this point. The variety under consideration was Rhode Island Greening.

No. of tree.	Whole No. of wormy fruits.	Entrance at calyx.	Entrance at side or base.	Ratio.	Remarks.
1	57	24	33	1:1.37	Sprayed twice,—1 lb. to 250 gallons.
2	39	14	25	1:1.78	" " " " "
3	96	32	64	1:2.00	Sprayed twice,—1 lb. to 300 gallons.
4	154	63	91	1:1.44	" " " " "
5	238	141	97	1:0.69	Not sprayed.
6	211	111	100	1:0.91	" "

It will be observed that while the absolute number of wormy fruits is greatly in excess, in case of the unsprayed trees, the relative number of entrances at the calyx is more than doubled. The most plausible explanation for this condition would seem to be that the poison lodging in the calyx, had destroyed the larvæ attempting to enter that end, while those entering the side or base escaped. The larvæ of the second brood were also exempt.

It was observed that a large proportion of the fruits infested, had been attacked by the second brood, and the larvæ were still present. To spray for this later brood is hardly practicable, but if the earlier brood is held in check, there will be less trouble from the later.

In many cases the casual observer would attribute injury to the codling moth, when in reality it is due to another insect—a species of *crambus.* The larva of this moth is smaller than that of the codling moth, and works only in the calyx. This insect was quite abundant the past season and rendered the work of examination for the codling larvæ more difficult.

5. *Is Sprayed Fruit Unwholesome?* The objection is frequently raised that fruit which has been sprayed is unsafe for food; that enough poison will adhere to render the fruit dangerous to health. The matter has attracted some attention in England recently, and there has been an outcry against American apples. One writer in the *Horticultural Times* of London, is quoted as saying: "If the American apple as it comes from the vessel is carefully rubbed with the finger, it will be seen that a fine, delicate powder is in most cases removed. This is the arsenic adhering to the skin." (!)

There certainly is no doubt that fruit from which a coating of arsenic may be rubbed, would be very unwholesome. The objection is not valid, however, as the fine, white powder *is not Paris green.* A large part of the fruit sent from this state is shipped in empty flour barrels; a fact which doubtless accounts for the fine, delicate powder on the fruit referred to. I have yet to see the fruit which at maturity showed any visible effects of spraying, unless it were comparative freedom from worminess.

The charge as to the unwholesome character of sprayed fruit has frequently been refuted, and it is only necessary to call attention to the amount applied, to render further argument unnecessary. The strongest mixture recommended is 1 pound to 200 gallons water. (If carefully applied there is little doubt that 1 pound to 250 gallons is strong enough.) If we apply two gallons of the mixture to a single tree, we should use approximately 1-100 of a pound, or 70 grains of the poison on the whole tree at each application. The fruits are so small at the time of spraying that it would be impossible to make so much as 5 per cent. of the poison stay on them. There is not sufficient surface to retain a larger amount. Supposing this proportion correct, however, and that the trees are sprayed twice, if there are 1,200 fruits—about three barrels—to the tree, the amount of poison per fruit would be less that 3-1000 (.0029) grain.

In our calculations we have not taken into account the fact that the fruit is exposed to sunshine and rain for four months before it is ready for use. On considering all phases of the question we are led to the conclusion that there is no reason why fruit sprayed as directed should be unwholesome when mature.

6. *When to Spray.* In planning the work for the season, it was designed to learn, if possible, the best time to spray, as well as the amount of poison necessary. Owing to pressure of other work, however, the instructions left by the writer were not fully carried out.

The time when the first brood commences depredations, is not fully determined by entomologists; but it certainly extends over a considerable period and varies with the season. Professor Gillette has shown that in some seasons, at least, and with certain varieties, the larvæ may not hatch in considerable numbers for at least a month after the blossoms fall.* It would seem unnecessary, in such cases, to spray at once. With many varieties, however, the calyx closes soon after the blossoms fall, and later applications of the poison will necessarily be more or less ineffectual.

No doubt the fact that experimenters use different varieties, causes much of the difference in opinion as to the proper time to spray, and the value of the later applications. In case of the Duchess, the spray will be just as effective a month after the blossoms fall as at an earlier date. Hence, if the larvæ do not appear earlier, a single application at the later date will be just as effectual as two or more applications, part of which are made as soon as the fruit sets. With the Baldwin, however, the conditions are different. About two weeks after the blossoms fall, the lobes of the calyx close, and while the eggs may have been deposited, the poison applied as a spray is shut out.

It will be seen that it is unsafe to generalize from the results obtained with either class of apples. It is hoped in our work of next season we shall be able to secure valuable data on this point.

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* Bulletin 7, Iowa Experiment Station, 277.

In general it is safe to say the proper time for the first application is just after the fruit has formed; and for the second, some two or three weeks later. In no case should any spraying be done while the trees are in blossom. It is too early to be of any value whatever in checking the work of the codling larvæ, and very serious damage may be done in poisoning the bees, which are very abundant at that season.

7. *Work in Other States.* As early as 1880, Professor A. J. Cook, of the Michigan Agricultural College, commenced the use of the arsenites in combatting the codling moth and other orchard pests. He has been an earnest advocate of spraying ever since, and has done much to bring the practise into popular favor in the West.

Professor E. S. Goff in 1884, conducted a series of experiments at the New York Agricultural Experiment Station, in which he found that 69 per cent. of injury was prevented by the use of Paris green. Similar results were obtained by Dr. S. A. Forbes, of Illinois, in 1885.

In 1889, Professor C. P. Gillette sprayed four Duchess trees with London purple, taking four contiguous trees as checks. "At the end of the season it was found that the treated trees had 68 per cent. less of wormy fruit than those not treated."*

Professor Gillette also tried a new method of applying poison to the trees. His method was the same as that used by many farmers in treating potato vines for the Colorado beetle, *i. e.* mix 1 pound Paris green with 100 pounds land plaster and throw the mixture over the trees when the dew is on. This method is of course impracticable for use in a large orchard, and is suggested only as a possible expedient for saving the fruit on a few trees about the house.

Professor Beckwith (Bul. XII, Del. Exp. Sta.) found that: "The percentage of wormy fruit from trees sprayed with either London purple or Paris green was from 18 to 35 per cent. less than from trees not sprayed. The greatest benefit was obtained when the trees were sprayed three times, using the mixture at the rate of 1 pound to 200 gallons of water."

These results are at variance with those obtained by Gillette, who found that: "There was practically no difference between once and twice spraying;" and "No. 7, which was treated late, was about as well protected as any."* It is probable that this disagreement is due, as before suggested, to the character of the varieties used in the trial.

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* Bulletin 7, Iowa Experiment Station.

From the experiments of Cook† and Bailey‡ the conclusion is reached that Paris green is much less liable to injure the foliage than is London purple. London purple is exceedingly variable in composition, and frequently contains large amounts of soluble arsenic—in some cases as much as 40 per cent. The presence of soluble arsenic is specially dangerous to foliage.

SUMMARY.

1. All sprayed trees had a smaller percentage of wormy fruit than did the unsprayed.

2. A mixture of one pound Paris green in 250 gallons water gave better results than did a weaker mixture; but

3. A mixture of 1 pound to 320 gallons, applied once, saved a large percentage of the fruit.

4. The number of windfalls was greatly lessened by spraying.

5. The proportion of wormy fruit among the windfalls was much smaller from the sprayed trees.

6. A large proportion of the wormy fruits from sprayed trees is entered from the side or base, while in fruits from unsprayed trees, the entrances at the calyx are largely in excess.

7. There is no danger from the use of fruit which has been sprayed as directed.

8. The best time to spray probably varies with different varieties, but in no case should any trees be sprayed before the blossoms fall.

9. The difference in the opinions of experimenters as to the proper time for spraying, is probably due to well known characteristics of different varieties.

10. There is greater liability to injury of foliage from the use of London purple than from the use of Paris green.

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* Bulletin 7, Iowa Experiment Station.

† Bulletin 53, Michigan Experiment Station.

‡ Bulletin 18, Cornell University Experiment Station.

II, Apple Scab, (*Fusicladium dendriticum.*)

It is not within the province of the writer to discuss in detail the characteristics of fungi injurious to fruits; but as no description of the disease known as *apple scab* has heretofore been published in the reports of the Experiment Station, it may be well to call attention, in a general way, to the nature of this disease.

All are familiar with the dark colored spots or scabs which appear on some varieties of apples,—notably the Fameuse, the Maiden Blush, and the Baldwin. These spots represent but one stage in the life history of a plant which grows on, and obtains its nourishment from the apple. In other words, apple scab is caused by the attack of a parisitic fungus—*Fusicladium dendriticum.* Its attack is not always confined to the fruit, and it is sometimes the cause of very serious loss to the orchardist.

The plant is reproduced by means of *spores,*[*] which are carried by the wind, and vegetate under favorable conditions. The most vigorous growth is made during cool, moist seasons. The climate of this state seems specially favorable for the growth of the fungus.

Figure 1 represents the disease as it appears on the fruit. In badly affected specimens the scabby spots are much larger and often cause the apple to crack. The nourishment is all taken from the affected side, and in consequence the fruit is deformed. If the fruits are very young when attacked, they usually wither and fall.

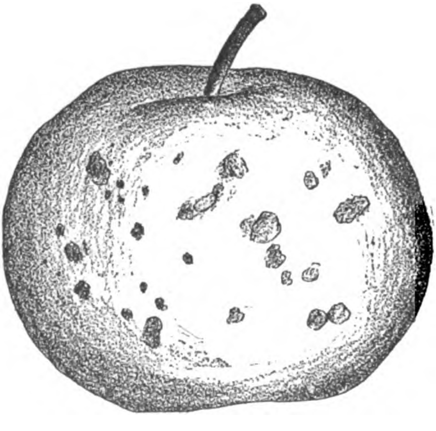

Fig. 1. A Diseased Apple.

The fungus attacks the leaves and young growing twigs as well as the fruit. If the attack occurs early in the season and is severe, much damage may result. The vitality of the tree is lessened, and the effects are accumulative, thus reducing the possibilities of future crops.

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[*] The appearance of these spores is illustrated in the report of the Maine Experiment Station for 1889, page 182.

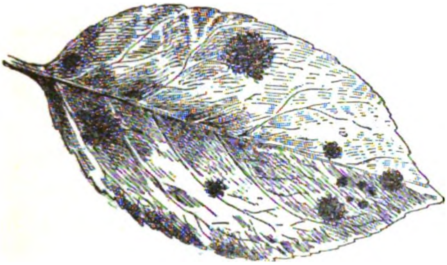

Figure 2 Scab Spots on a Leaf.

The disease first appears on the leaves as brownish or olive-colored spots, as shown in figure 2. These spots, if numerous, run together and finally become blackish, and the leaf tissue dies. The effect on young foliage, attacked early in the season, is well shown in figure 3.* The cut is from a photograph taken in August and shows, on the left, a full sized leaf which developed after the first attack of the fungus. If the attack occurs later in the season, after the year's growth is nearly completed, but little injury is wrought.

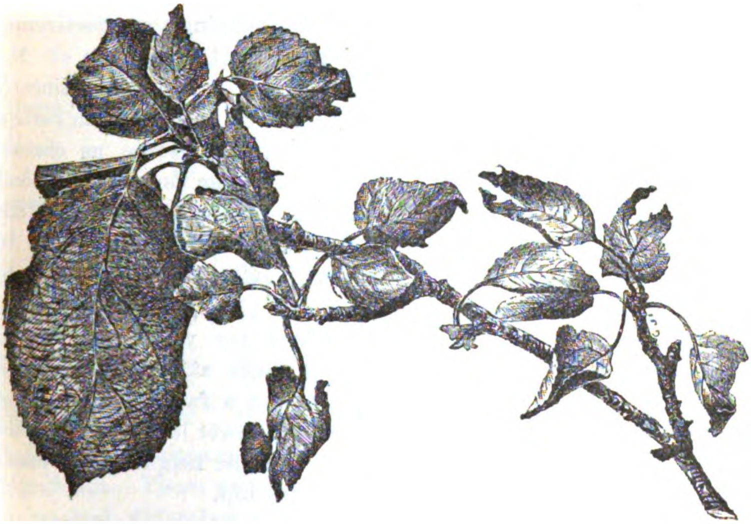

Fig. 3. Blighted Foliage.

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* The plates for figures 2 and 3, were loaned us by the Cornell University Experiment Station.

RESULTS OF SPRAYING.

For several seasons past, experiments have been conducted in various states for the purpose of determining a successful method of controlling the apple scab fungus. It has been found that in many instances much benefit is derived from the use of solutions of some of the compounds of copper.

During the past season a series of experiments was planned with the purpose in view of determining on an extended scale the effectiveness of certain mixtures, and some of the problems relative to methods of application. The latter and most extensive portion of the work was carried on in the orchard of F. M. Woodward of Winthrop, the work being conducted by Mr. C. E. Moore, under the direction of the writer. Owing to local conditions, most of the problems under consideration remain unsolved. Much credit is due Mr. Moore, however, for the faithfulness with which he attended to the spraying. The work will be continued next season.

The first part of the work, that of determining the effectiveness of certain compounds, was carried on in the orchards of Mr. Charles S. Pope, of Manchester, and the results were eminently satisfactory. Fifty-nine Baldwin trees were sprayed with various mixtures, and a suitable number was left to serve as checks. The trees were of medium size and bore from one and one-half to three barrels of fruit. The time at command when the fruit was gathered was so limited that all of the trees could not be examined critically; but a sufficient number was examined to give a fair basis for our conclusions.

In gathering the fruit, except where the whole was taken, about two and one-half bushels were taken at random from all parts of each tree, the plan being to get a fair average of the fruit. The baskets were filled from the lower limbs on all sides of the tree; then from the branches at the height of a man's head; then higher, and finally in the very top.

Four different solutions were used:

A.—A modified form of *eau celeste*.

B.—Ammoniacal solution of copper carbonate, using 3 ounces copper carbonate, 1 quart ammonia, and 30 gallons water.

C.—Same as B, except that but 2 ounces of copper carbonate was used.

D.—Copper carbonate in suspension—2 ounces copper carbonate in 25 gallons water.

The unsprayed trees were so distributed as to serve as checks for more than one solution.

The accompanying table gives a comprehensive view of the results obtained.

TABLE VII.—*Effects of Copper Solution on Apple Scab.*

Solution used.	Number fruits examined.	Free from scab.	Slightly scabby.	Badly scabbed.	Worthless.	Per cent. free.	Per cent. "No. 1" fruit (as regards scab).	Remarks.
A.								
	383	231	52	78	22	60.3	73.9	
	264	138	85	33	8	52.3	84.5	
	441	160	193	74	14	36.3	80.0	
	473	276	121	66	10	58.4	83.9	
	732	504	189	34	5	68.9	94.7	
Average per tree	**459**	**262**	**125**	**57**	12	57.0	85.0	
B.								
	972	318	524	120	10	32.7	86.7	
	780	463	262	48	7	59.4	92.9	
	541	278	226	37	0	51.4	93.1	
	918	471	345	94	8	51.3	88.9	
Average	**802**	**383**	**339**	**78**	**6**	47.8	90.0	
C.								
	936	271	506	149	10	28.9	83.0	About three-fourths of the fruits classed as slightly scabby were better fruits than those free from attack.
	734	200	391	129	14	27.3	80.5	
	490	239	196	50	5	48.8	88.9	
Average	**720**	**237**	**364**	**109**	**10**	32.9	83.5	
D.								
	669	15	148	329	177	2.2	24.4	Sprayed 3 times: May 22, June 15, July 28.
	484	18	146	233	87	3.7	33.9	
	658	42	147	299	165	6.4	28.9	Sprayed once, May 23.
	488	20	112	252	104	4.1	27.0	
Average	**576**	**24**	**138**	**278**	**133**	4.1	28.1	
CHECKS.								
	526	10	135	205	176	1.9	27.5	
	1046	23	156	508	359	2.2	17.1	
	615	58	179	283	95	9.4	38.5	
Average	**729**	**30**	**157**	**332**	**210**	4.1	25.6	

The table appears somewhat formidable, but the figures are significant. There was in every instance save one,—solution D,—a marked difference in the amount of scab on sprayed and unsprayed trees.

The highest per cent. of fruit free from scab was obtained from the use of the *eau celeste*, the gain being 52.9 per cent. or more than half the crop. The greatest actual gain, in the quantity of marketable fruit, however, was obtained from the use of the stronger solution of copper carbonate. The actual increase of

No. 1 fruit over the amount on unsprayed trees, in this case amounted to nearly 65 per cent. A closer comparison of the results with the different solutions is not made, because of a lack of uniformity in time of application.

The results obtained from the use of solution D—copper carbonate in suspension, will not warrant us in advising the use of that mixture. Our results from the use of this mixture are directly opposed to those obtained at some other experiment stations. At the Central Experiment Farm of Canada, Mr. Craig found the use of copper carbonate in suspension to make a difference of 26 per cent. in the number of fruits of the first quality, while the ammoniacal solution gave an increase of only 9 per cent.* In our work, as will be seen from the above table, there was *no* increase in the number of perfect fruits in the case of trees sprayed with solution "D," as opposed to an increase of 43.6 per cent. on trees sprayed with "B"—the ammoniacal solution. It will also be observed, that repeated applications of the mixture were of no value. The per cent. of fruit entirely free from scab, was actually higher on trees sprayed but once than on those sprayed three times.

The effect of the treatment with solutions A and B was even more marked in another of Mr. Pope's orchards. This orchard, which has been set about forty years, is located on a hillside with northwestern aspect. The orchard was used as a pasture for hogs, and the trees were growing vigorously.

Alternate rows were sprayed with solution A, the application being made May 11, before the buds opened, and June 19. The results were sufficiently marked so that it was possible to go into the middle of the orchard and determine which were the sprayed and which the unsprayed rows, from the general appearance of the trees.

Some of the trees in the check rows were sprayed May 22, and June 22 with solution B, the results being nearly as satisfactory as obtained with solution A. The fruit from four trees standing in immediate proximity to each other, was counted with the result shown in the table.

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* Cf. Bul. 10, Central Exp. Farm.

Treatment.	No. fruits examined.	Free from scab.	Slightly scabby.	Badly scabbed.	Worthless.	Per cent. free.	Per cent. No. 1 apples (as regards scab).	Remarks.
Solution A.	414	247	145	22	0	59.7	94.7	Sprayed twice,—May 11 and June 13.
Solution B.	461	183	232	91	5	28.9	79.2	Sprayed twice,—May 22 and June 22.
Check	474	35	191	219	29	7.4	47.6	Not sprayed.
Check	430	45	196	163	26	10.4	56.0	" "

It will be noticed that there is a decided difference between the unsprayed trees and the trees sprayed with either solution. The least difference, that between the best check tree and the tree sprayed with copper carbonate, was 18.5 per cent. of fruit absolutely free from scab, and 23.2 per cent. of fruit which would be classed as "No. 1."

It will also be observed, that in this instance the *eau celeste* gave better results than did the copper carbonate in an orchard where the efficiency of both might well be tried. Definite conclusions should not be drawn from results obtained with so few trees; but it may be seen that the results correspond very nearly to those in the first table. The per cent. of fruits absolutely free from scab is much larger on the tree sprayed with *eau celeste*, while those but slightly attacked preponderate on the other; thus bringing the percentage of salable fruits up well toward the first.

When it is considered that the cost of spraying a single tree is only about *three* cents for each application, the figures given above are very significant.

As before stated, most of the work in Mr. Moore's orchard, where methods of application and the merits of different solutions were under study, was of no value. A few trees in an old orchard near the house were sprayed in such a manner, however, that it is possible to get some idea of the relative value of spraying. The treatment was not continued during the season, as the trees were not included in the original plan of the experiment.

Two rows in an orchard perhaps forty years old, were sprayed on May 21, and June 12, with carbonate of copper in suspension—2 ounces to 30 gallons water—and Paris green, 1 pound to 250 gallons. In an adjacent row, the trees were sprayed once, June 15, with the ammoniacal solution—solution A. As seen in

Table VII, trees sprayed with copper carbonate in suspension were little better than unsprayed trees, and for comparison they may be regarded as checks.

The fruit from several trees was examined, with the following result:

	No. fruits examined.	Free from scab.	Slightly scabby.	Badly scabbed.	Worthless.	Per cent. free.	Per cent. No. 1 fruit.	
Copper carbonate in suspension, (check)....	492	3	123	257	108	.6	25.6	Average of three trees.
Ammoniacal solution of copper carbonate...	556	19	184	264	86	3.4	36.5	Average of two trees.

In another part of the same orchard two contiguous trees were examined with very similar results.

As will be seen at a glance, this orchard suffered very severely. Some trees were absolutely without a perfect fruit, and the average amount of fruit that would pass as No. 1, was but little more than one-fourth of the crop. The difference between sprayed and unsprayed trees is not very marked, but the figures point to the fact that there are uniformly beneficial results, even from limited applications.

An exception to the last statement may be noted in the case of a single tree in Mr. Pope's orchard. This tree was sprayed three times with *eau celeste*, the last application being made July 28. The amount of scabby fruit was slightly in excess of the average amount on unsprayed trees. The only explanation we can offer is that the leaves fell very badly, and the tree was less able to withstand the attack of the fungus late in the season. Any plant of weakened vitality is more subject to disease than is one of vigorous constitution.

HOW TO PREPARE THE MIXTURES.

Directions for preparing the modified *eau celeste*, and the ammoniacal solution of copper carbonate, as used at other experiment stations, were given in the report of this station for 1889. It may be well, however, to refer to the subject in the present connection.

Solution A.—Modified Eau Celeste.

Dissolve 2 pounds sulphate of copper, ("Blue stone"), in 2 gallons hot water. In another vessel dissolve 2 1-2 pounds carbonate of soda (sal soda); mix the two solutions, and, when ready for use, add 1 1-2 pints strong ammonia water and dilute the whole to 28 gallons. The sulphate of copper should be dissolved in a *wooden* vessel as zinc or iron will corrode.

It is well to make the stock solution at least one day before it is wanted for use, and to mix a considerable quantity, merely observing the proportions suggested.

Solution B.—Ammoniacal Solution of Copper Carbonate.

The formula used in most of our work was as follows:

3 oz. copper carbonate.
1 qt. ammonia.
30 gal. water.

Dissolve the carbonate of copper in the ammonia and when ready for use add to the required amount of water. As with the *eau celeste*, the solution should be made several hours before desired for use.

The ammonia used in our work was nearly 26° Baumé (sp. grav. ——); and in some instances the foliage was injured. In the later applications the solution was diluted to 35 gallons, and it is probable that 40 gallons would be better.

It was found that only about 1 1-2 ounces of the copper carbonate would dissolve in one quart of ammonia; still better results were obtained from the use of the 3 ounces than from solution C, in which only 2 ounces copper was used in a quart of ammonia. Why this is so is not clear, since the simple copper carbonate in suspension appeared to have no value.

An improved formula for the ammonio-copper carbonate solution has been recommended. It is as follows:

3 oz. carbonate of copper.
1 lb. carbonate of ammonia.
50 gal. water.

Mix the carbonate of copper and the carbonate of ammonia thoroughly, and dissolve the mixture in two quarts of hot water. This solution may then be added to the full amount of water; or a considerable quantity may be prepared and used as a stock solution.

Solution D, copper carbonate in suspension, is not a true solution, as the copper carbonate is not soluble in water. It is made by adding a given amount of the copper salt to the water and, as in the case of Paris green, the particles are held in suspension by continual agitation. This mixture is not recommended for general use.

Where to Procure the Chemicals.

The ingredients of the modified *eau celeste*, may all be obtained at any local drug store. If any considerable quantity is to be used, however, it is much cheaper to send to some reliable wholesale house and buy in bulk. For this reason it is well for farmers to club together in securing a supply of chemicals. Carbonate of copper is not usually handled by local dealers, and in ordering, it is well to specify that the *precipitated* form is desired.

The following firms are named as reliable parties who will supply the various materials at a reasonable cost:

Weeks & Potter Co., Washington street, Boston.
Eimer & Amend, 205 Third Avenue, New York.
W. S. Powell & Co., 202 Bowley's Wharf, Baltimore, Md.

Some dealers offer the ammoniated copper carbonate, "copperdine," ready for use by diluting with the proper amount of water. In this way less labor is required in preparation, but the ingredients are much more costly.

SUMMARY.

1. Apple scab is caused by the attack of a parasitic plant—a fungus.

2. The fungus attacks the leaves and young twigs, as well as the fruit, and may seriously injure the tree.

3. The attack is most severe in cool, moist seasons.

4. Spraying with certain compounds of copper will hold the fungus in check.

5. In some cases the amount of No. 1 fruit on the sprayed trees exceeded that on unsprayed trees by 65 per cent. while the average increase of salable fruit was more than 50 per cent.

6. There appears to be little difference in effectiveness between the ammoniacal solution of copper carbonate, and modified eau celeste.

7. Three ounces copper carbonate dissolved in one quart ammonia gave better results than did a smaller proportion.

8. Carbonate of copper in suspension appears to be of no value as a fungicide.

9. The cost of spraying with eau celeste or the ammoniacal solution of copper carbonate, is about three cents per tree for each application.

III, Spraying Apparatus.

In the report of the Experiment Station for 1889, may be found figures and descriptions of several desirable force pumps and spraying nozzles. In addition to those there enumerated, we have used several others with which we are well pleased.

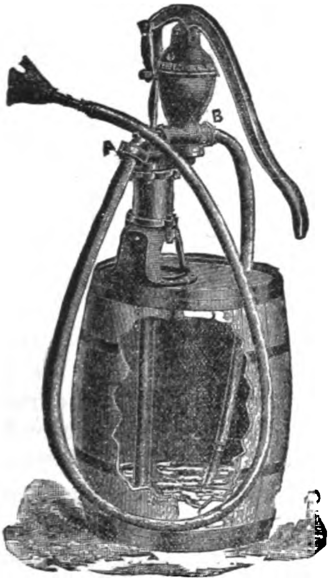


Fig. 4.
"Perfection" Spraying Outfit.

Figure 4 represents the "Perfection" outfit. This is the pump we have used in most of our field work. The pump is supplied with about ten feet of hose, and also has a second discharge pipe returning to the bottom of the barrel, thus keeping the mixture agitated. The cost of the pump with brass cylinder and plunger is $11.50. It is manufactured by the Field Force Pump Co., Lockport, N. Y. Other pumps of a similar style may be obtained of the Gould Manufacturing Co., Seneca Falls, N. Y., also of Rumsey & Co., of the same place.

In large orchards it is no small task to work the pump by hand and there is a demand on the part of owners of such orchards for a labor-saving device. To meet this demand, several styles of pumps with automatic gearing, have been constructed. One of these, the "Victor," made by the same company as the "Perfection" outfit. is shown in figure 5.

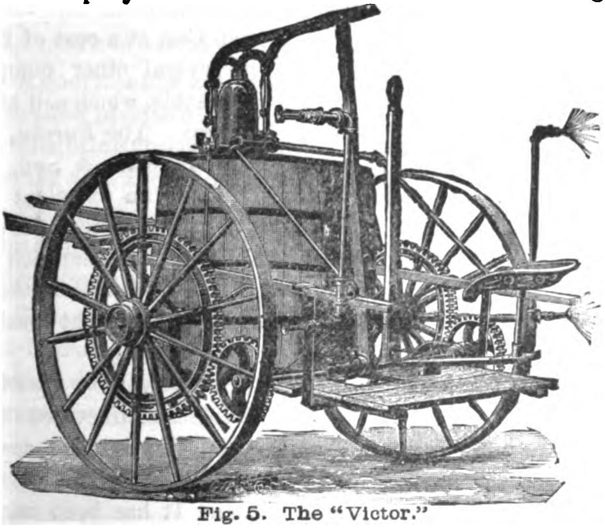


Fig. 5. The "Victor."

At a relatively small expense any of the hand pumps may be made to work automatically. Get a casting similar to that used on a hay tedder, with a small wheel to match, and with a bent crank-shaft the motion may readily be transmitted to the handle of the pump.

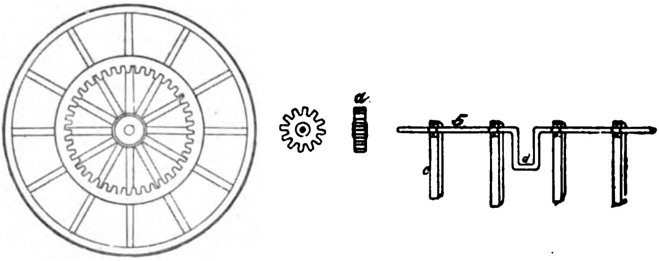


Fig. 6.

The accompanying sketch, figure 6, illustrates the method. The small wheel, *a*, works inside of the large cog-wheel. The crank shaft, *b*, is held firmly in place at the rear of the cart by the iron or wooden supports, *c*. The handle of the pump is connected with the crank shaft at *d* by means of a wooden rod. This method has been used to some extent, but I am not aware that it is patented.

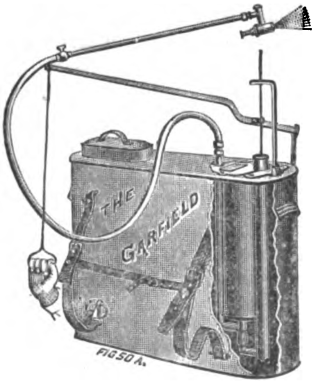


Fig. 7.

For shrubs, or low growing trees, one of the various knapsack sprayers will be found useful. Figure 7 represents the form made by the Field Force Pump Co., at a cost of $14.00. There are several other pumps not greatly unlike this, which sell at about the same price. The *Eureka*, manufactured by Adamson & Son, Washington, D. C., is an excellent pump, but is more expensive than the others, costing $21.00. The knapsack sprayers are specially valuable in the small fruit, and vegetable gardens, for spraying currant bushes or potato vines.

We have not succeeded in finding a nozzle more satisfactory for general purposes than the *Climax*, manufactured by the Nixon Nozzle & Machine Co., Dayton, Ohio. This nozzle is specially valuable in the application of Paris green, when fineness of spray is the great desideratum. It has been suggested that a battery of these nozzles leading from a common chamber, would be an improvement over the present form. The aperture is so small in the form now in use, that too much time is lost in applying the liquid.

The "graduated spray" nozzle, which goes with the Perfection outfit, is good when accurately made, but if the central column is not quite true, the spray is uneven. This nozzle requires heavy pressure to give a satisfactory spray.

The knapsack sprayers are usually supplied with the vermorel nozzel, the form of which may be seen in figure 7.

GENERAL SUMMARY.

1. The work of the Horticultural Department during the past year has been largely in the way of organization.

2. The principal lines of investigation are in the study of the effects of climate on plant variation; effects of pollination; studies of the egg plant and the pepino; the amelioration of native fruits by selection and crossing; methods of culture of certain garden vegetables in the field and under glass; methods of combating orchard pests.

3. Experiments in the culture of cabbages show that the best results are obtained by frequent transplanting; that in general, depth of setting has little influence on the size of the heads; that disturbing the roots in transplanting has no marked effect on size of head or time of maturity.

4. Experiments with tomatoes show that frequent handling makes plants stocky; that early setting is advisable; that trimming the plants is an effective method of hastening maturity and increasing yield.

5. Egg plants may be successfully grown in this region by starting the plants early, and giving them rich soil and thorough cultivation.

6. The collection of fruits on the grounds of the experiment Station has been materially increased, but special attention is being given to developing varieties suited to the more trying localities of the state.

7. As a result of spraying apple trees with Paris green, it was found that all sprayed trees had less wormy fruit

than did the unsprayed trees; that the number of windfalls was greatly lessened by spraying; that the best time to spray probably varies with different varieties, but in no case should spraying be done before the blossoms fall. There is no danger from the use of fruit which has been sprayed as directed.

8. Spraying with the ammoniacal solution of copper carbonate, or with the modified *eau celeste*, is effective in checking the ravages of the apple scab fungus; but copper carbonate in suspension appears to have no value as a fungicide. The cost of spraying with *eau celeste* or with the ammoniacal solution of copper carbonate is about three cents per tree, for each application.

FERTILIZER EXPERIMENTS.

PROF. WALTER BALENTINE.

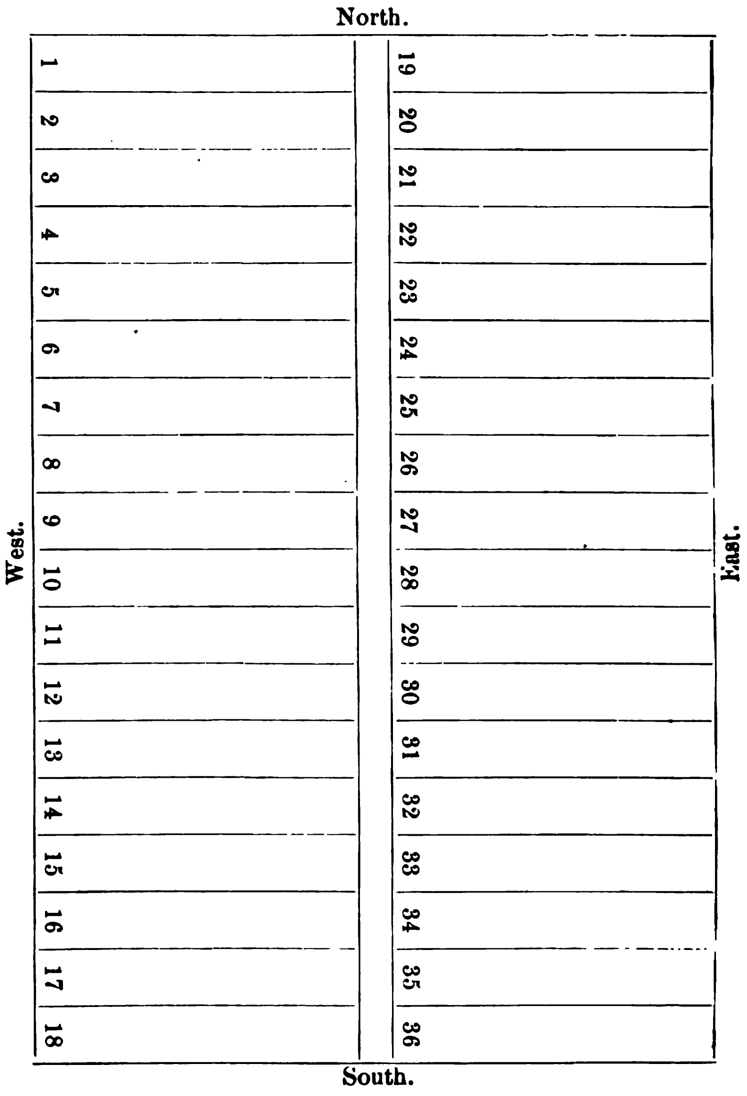
EFFECT OF DIFFERENT FORMS AND MIXTURES OF FERTILIZERS.

For the past six years the Station has been engaged continuously on the same land, with experiments, having for their object (1) The comparative effect of different forms of phosphoric acid in manuring crops; (2) A comparison between commercial fertilizers and stable manure in crop production; (3) The effect of a partial and complete fertilizer; (4) A comparison of the effect of different quantities of fertilizers.

The results of this work have been published from time to time in the Station Reports. Each year adds a little to the interest and value of the data obtained and the writer ventures to give, in connection with the report of the experiments of this year a review of those of preceding years.

The soil, or the field on which these experiments were carried out, was in condition to produce a fair crop of hay or grain, when the work was commenced. Thirty-six one-twentieth acre plots were laid off and numbered as indicated in the accompanying diagram of Experiment Field, No. 1.

DIAGRAM OF EXPERIMENTAL FIELD NO. 1.



In 1886, 1887 and 1889 the plots were treated as indicated in the following table, on each of the three years, so that the total amount of fertilizers applied during the six years that this field has been cultivated experimentally is three times the amounts given in the table, no fertilizer being applied in 1888, 1890 and 1891.

Plot 1 " 7 " 13	Received no fertilizer.	
Plot 2 " 8 " 14	Dissolved bone black, Muriate of potash, Sulphate of ammonia,	400 lbs. per acre. 100 " " " 200 " " "
Plot 3 " 9 " 15	Fine ground bone, Muriate of potash, Sulphate of ammonia,	360 lbs. per acre. 100 " " " 140 " " "
Plot 4 " 10 " 16	Fine ground South Carolina rock, 300 lbs. per acre. Muriate of potash, 100 lbs. per acre. Sulphate of ammonia, 200 lbs. per acre.	
Plot 5 " 11 " 17	Muriate of potash, 100 lbs. per acre. Sulphate of ammonia, 200 lbs. per acre.	
Plot 6 " 12 " 18	Stable manure, 40,000 lbs. per acre.	
Plot 19 " 25 " 31	Received no fertilizer.	
Plot 20 " 26 " 32	Dissolved bone black, 400 lbs. per acre.	
Plot 21 " 27 " 33	Dissolved bone black, Muriate of potash,	400 lbs. per acre. 100 " " "
Plot 22 " 28 " 34	Dissolved bone black, Muriate of potash, Sulphate of ammonia,	200 lbs. per acre. 50 " " " 60 " " "
Plot 23 " 29 " 35	Dissolved bone black. Muriate of potash, Sulphate of ammonia,	300 lbs. per acre. 100 " " " 120 " " "
Plot 24 " 30 " 36	Dissolved bone black, Muriate of potash, Sulphate of ammonia.	400 lbs. per acre. 150 " " " 180 " " "

In 1886 and 1887, the field was cropped with oats, in 1888 with grass. In 1889 the land was fallow. In 1890, a crop of peas was taken off and 1891 another crop of oats.

COMPARATIVE EFFECT OF DIFFERENT FORMS OF PHOSPHORIC ACID.

Included in the tables showing the results of experimental work in this direction, are a set of plots that have been cultivated without manure, a set manured with stable manure from cows, and a set manured with muriate of potash and sulphate of ammonia. The three sets of plots which have been furnished phosphoric acid have been treated like the last named set with the addition of the phosphates.

Table A gives the yields per plot and the average yield per plot for the present year.

Table B shows the average yield per acre, the gains of the manured plots over the unmanured plots, and the gain per acre of the plots manured with phosphates, muriate of potash and sulphate of ammonia over those manured with muriate of potash and sulphate of ammonia alone.

Table C gives the yields for each year and the total yields of each crop.

TABLE A.

	No Manure.		Dissolved Bone Black 400 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 200 lbs. per acre, in 1886, 1887, and 1889.		Fine Ground Bone 300 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 140 lbs. per acre, in 1886, 1887, and 1889.		Fine Ground South Carolina Rock 300 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 200 lbs. per acre, in 1886, 1887, and 1889.		Muriate of Potash 100 lbs., and Sulphate of Ammonia 200 lbs. per acre, in 1886, 1887, and 1889.		Stable Manure 40,000 lbs. per acre in 1886, 1887, and 1889.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
Plot 1	75.5 lbs.	59.5 lbs.										
" 7	50.0 "	25.0 "										
" 13	50.0 "	25.0 "										
" 2			73.0 lbs.	67.0 lbs.								
" 8			66.0 "	39.0 "								
" 14			63.0 "	42.0 "								
" 3					68.5 lbs.	71.5 lbs.						
" 9					67.3 "	32.7 "						
" 15					70.7 "	59.2 "						
" 4							58.5 lbs.	41.5 lbs.				
" 10							53.7 "	36.3 "				
" 16							61.5 "	38.5 "				
" 5									58.0 lbs.	47.0 lbs.		
" 11									59.5 "	20.5 "		
" 17									77.0 "	38.0 "		
" 6											75.3 lbs.	74.8 lbs.
" 12											87.0 "	58.0 "
" 18											71.0 "	129.0 "
Average	58.3 lbs.	36.3 lbs.	67.3 lbs.	49.3 lbs.	68.8 lbs.	54.5 lbs.	58.0 lbs.	38.8 lbs.	64.8 lbs.	35.2 lbs.	77.1 lbs.	87.3 lbs.

TABLE B.

	Fertilizers per acre for the years 1886, 1887, and 1889, in lbs.	Average yield per acre of oats, in bushels.	Average yield per acre of straw, in lbs.	Av'ge increase of grain of manured plots over unmanured plots per acre, in bushels.	Av'ge inc. of grain per acre in bu., of plots receiving phosphoric acid with potash & nitrogen, over those receiving only potash & nitrogen.
No manure		38.9	728		
Dissolved bone black	400				
Muriate of potash	100	44.9	986	6.0	1.7
Sulphate of ammonia	200				
Fine ground bone	3 0				
Muriate of potash	100	45.9	1090	7.0	2.7
Sulphate of ammonia	140				
Fine ground S. C. rock	8 0				
Muriate of potash	100	38.7	776	—0.2	—4.5
Sulphate of ammonia	200				
Muriate of potash	100	43.2	704	4.3	
Sulphate of ammonia	200				
Stable manure	40,000	51.4	1746	12.5	

TABLE C.

	No Manure.	Dissolved Bone-black 400 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 200 lbs. per acre, in 1886, 1887, and 1889.	Fine Ground Bone 300 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 140 lbs. per acre, in 1886, 1887, and 1889.	Fine Ground South Carolina Rock 300 lbs., Muriate of Potash 100 lbs., Sulphate of Ammonia 200 lbs. per acre, in 1886, 1887, and 1889.	Muriate of Potash 100 lbs., and Sulphate of Ammonia 200 lbs. per acre, in 1886, 1887, and 1889.	Stable Manure 40,000 lbs. per acre, in 1886, 1887, and 1889.
	Yield per acre.	Yield per acre.	Yield per acre.	Yield per acre.	Yield per acre.	Yield per acre.
Oats, 1886	55.7 bush. of 30 lbs,	82.9 bush. of 30 lbs.	76.2 bush. of 30 lbs.	72.2 bush. of 30 lbs.	64.5 bush. of 30 lbs.	73.9 bush. of 30 lbs.
Oats, 1887	26.7 “ “	38.7 “ “	31.9 “ “	35.5 “ “	35.1 “ “	34.7 “ “
Hay, 1888	2566 lbs.	2434 lbs.	2800 lbs.	2566 lbs.	2234 lbs.	4010 lbs.
Fallow, 1889						
Peas, 1890	12.3 bush. of 60 lbs.	15.0 bush. of 60 lbs.	15.7 bush. of 60 lbs.	14.3 bush. of 60 lbs.	12.7 bush. of 60 lbs.	22.7 bush. of 60 lbs.
Oats, 1891	38.9 “ 30 lbs.	44.9 “ 30 lbs.	45.9 “ 30 lbs.	38 7 “ 30 lbs.	43.2 “ 30 lbs.	51.4 “ 30 lbs.
Total crop in 6 years.						
Oats	121.3 bushels.	166.5 bushels.	154.0 bushels.	146.4 bushels.	142.8 bushels.	160.0 bushels.
Hay	2566 lbs.	2434 lbs.	2800 lbs.	2566 lbs.	2234 lbs.	4010 lbs.
Peas	12.3 bushels.	15.0 bushels.	15.7 bushels.	14.3 bushels.	12.7 bushels.	22.7 bushels.

An examination of table A shows that the set of plots which has been cultivated for six years without manure has yielded the present year 38.9 bushels of oats.

The following three sets of plots have each received during the six years three applications of what is called a complete fertilizer, that is, a fertilizer containing phosphoric acid, potash and nitrogen. The only difference in the treatment of the three sets of plots being that the source of phosphoric acid in the first set was dissolved bone black, in the second fine ground bone, and in the third fine ground South Carolina rock. This year's crop shows but little difference between the effectiveness of the phosphoric acid from dissolved bone black and fine ground bone. It should be remembered, however, that this crop was grown two years after the last application of the fertilizers and the soluble phosphoric acid of the dissolved bone black had, without doubt, reverted.

Little can be said in regard to the crop produced with South Carolina rock as a source of phosphoric acid. These plots gave a crop which was no greater than that obtained on the unmanured plots, and was less than was obtained on plots manured with muriate of potash and sulphate of ammonia with no South Carolina rock.

No explanation is known for this variation in the crop of the South Carolina rock plots, from what might have been expected.

The product on the plots manured with commercial fertilizers was unsatisfactory, considering the treatment they had received in the way of fertilizers.

Table C furnishes the data for studying the effect of the phosphoric acid from different sources through the six years since the experiment was commenced. Dissolved bone black gives the largest total yield of oats, the second largest yield of peas and the smallest yield of hay. Fine ground bone has given the largest yield of hay and peas and the second largest yield of oats. The South Carolina rock is second in yield of hay and third in yield of oats and peas.

The plots manured with commercial fertilizers gave large yields the first year of the experiment, two sets even exceeding the yield of the stable manure plots. The second year of the experiment the weather was unfavorable and the yield on all plots was light. The stable manure has, however, with the exception of that year, given uniformly good crops, while those upon which commercial fertilizers were used have not produced what could be called a paying crop since the first year. The question naturally arises, why did we obtain so good results the first year with commercial fertilizer and such indifferent results in subsequent years. Many farmers who have tried to run a field with commercial fertilizers alone for a series of years have been confronted with the same facts that are encountered here.

The experiments do not furnish the data for a definite answer but attention is called to certain facts in connection with the history of this field. At the first plowing there was a heavy sod turned under which insured a first class mechanical condition of the soil for the crop that followed. Since that time, although grass has been produced on the field one season, no crop has been grown on sod as the ground was fallow the year following the grass crop. On the plots manured with stable manure large amounts of organic matter have been supplied in the manure which, on a stiff clay loam like the soil in the experiment, insures a better mechanical condition for the growth of crops.

SUMMARY.

(1.) On sod land all of the phosphates used in the experiment have been effective.

(2.) With oats, dissolved bone black has produced on the average the largest crop.

(3.) With peas and hay there has been but little difference in the effectiveness of the three phosphates used.

THE EFFECT OF A PARTIAL AND COMPLETE FERTILIZER.

The object of this experiment is to determine the needs of the soil of the College Farm and the special need of different crops on that soil.

The ordinary definition of a complete fertilizer is, one that furnishes all three of the elements which are most likely to be deficient in the soil, namely, potash, phosphoric acid and nitrogen.

A partial fertilizer is one from which one or two of the above named elements are omitted. It is in this sense that the terms partial and complete fertilizers are used.

Table D shows the quantity of oats produced the present year on unmanured plots, on plots manured with muriate of potash and sulphate of ammonia, on plots manured with dissolved bone black, on plots manured with dissolved bone black and muriate of potash, and two sets manured with complete fertilizers. Table E gives the average yields per acre of the same and the gains per acre of the manured plots over the unmanured plots. Table F gives the average yields for each year and the total yields of the different crops for the period of six years.

TABLE D.

	No Manure.		Muriate of Potash 100 lbs. and Sulphate of Ammonia 200 lbs. per acre in 1886, 1887, and 1889.		Dissolved Bone-black 400 lbs. per acre, in 1886, 1887, and 1889.		Dissolved Bone-black 400 lbs., Muriate of Potash 100 lbs. per acre, in 1886, 1887, and 1889.		Dissolved Bone-black 400 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 200 lbs. per acre, in 1886, 1887, and 1889.		Dissolved Bone-black 400 lbs., Muriate of Potash 150 lbs., and Sulphate of Ammonia 180 lbs. per acre, in 1886, 1887, and 1889.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
Plot 1	75.5 lbs.	59.5 lbs.										
" 7	50.0 "	25.0 "										
" 13	50.0 "	25.0 "										
" 19	69.0 "	61.0 "										
" 25	55.0 "	50.0 "										
" 31	54.8 "	20.3 "										
" 5			58.0 lbs.	47.0 lbs.								
" 11			59.5 "	20.5 "								
" 17			77.0 "	38.0 "								
" 20					62.0 lbs.	78.0 lbs.						
" 26					64.0 "	66.0 "						
" 32					62.5 "	67.5 "						
" 21							53.0 lbs.	67.0 lbs.				
" 27							60.0 "	65.0 "				
" 33							76.5 "	78.5 "				
" 2									73.0 lbs.	67.0 lbs.		
" 8									66.0 "	39.0 "		
" 14									63.0 "	42.0 "		
" 24											60.0 lbs.	70.0 lbs.
" 30											63.0 "	67.0 "
" 36											68.8 "	71.2 "
Average	57.0 lbs.	40.1 lbs.	61.5 lbs.	35.2 lbs.	62.8 lbs.	70.5 lbs.	63.2 lbs.	70.2 lbs.	67.3 lbs	69.3 lbs.	58.9 lbs.	69.4 lbs.

TABLE E.

	Fertilizers per acre in 1886, 1887, and 1889.	Yield of Oats per acre, in bushels.	Yield of Straw per acre, in lbs.	Increase of grain in bush., of manured plots over unmanured plots.
No manure		38.0	802	
Muriate of potash	100 lbs.	41.0	704	3.0
Sulphate of ammonia	200 "			
Dissolved bone-black	400 "	41.2	1410	3.2
Dissolved bone-black	400 "	42.1	1404	4.1
Muriate of potash	100 "			
Dissolved bone-black	400 "	44.9	1346	6.9
Muriate of potash	100 "			
Sulphate of ammonia	200 "			
Dissolved bone-black	400 "	42.6	1388	4.6
Muriate of potash	150 "			
Sulphate of ammonia	180 "			

TABLE F.

	Yield with no Manure.	Yield with Muriate of Potash 100 lbs., and Sulphate of Ammonia 200 lbs. per acre, in 1886, 1887, and 1889.	Yield with Dissolved Bone black 400 lbs. per acre, in 1886, 1887, and 1889.	Yield with Dissolved Bone-black 400 lbs., and Muriate of Potash 100 lbs. per acre, in 1886, 1887, and 1889.	Yield with Dissolved Bone-black 400 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonium 200 lbs. per acre, in 1886, 1887, and 1889.	Yield with Dissolved Bone-black 400 lbs., Muriate of Potash 150 lbs., and Sulphate of Ammonium 180 lbs. per acre, in 1886, 1887, and 1889.
Oats, 1886	54.1 bush. of 30 lbs.	64.5 bush. of 30 lbs.	55.2 bush. of 30 lbs.	54.3 bush. of 30 lbs.	82.9 bush. of 30 lbs.	68.0 bush. of 30 lbs.
Oats, 1887	27.4 " "	35.1 " "	28.1 " "	24.4 " "	38.7 " "	40.5 " "
Hay, 1888	2100 lbs.	2334 lbs.	2166 lbs.	2066 lbs.	2434 lbs.	2374 lbs.
Fallow, 1889	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
Peas, 1890	12.5 bush. of 60 lbs.	12.7 bush. of 60 lbs.	14.2 bush. of 60 lbs.	15.0 bush. of 60 lbs.	15.1 bush. of 60 lbs.	15.9 bush. of 60 lbs.
Oats, 1891	38.0 " 30 lbs.	41.0 " 30 lbs.	41.2 " 30 lbs.	42.1 " 30 lbs.	44.9 " 30 lbs.	42.6 " 30 lbs.
Total crop in 6 yrs.						
Oats	119.5 bushels.	140.6 bushels.	124.5 bushels.	120.8 bushels.	166.5 bushels.	151.0 bushels.
Hay	2100 lbs.	2336 lbs.	2166 lbs.	2066 lbs.	2434 lbs.	2374 lbs.
Peas	12.5 bushels.	12.7 bushels.	14.2 bushels.	16.0 bushels.	15.1 bushels.	15.9 bushels.

Tables D and E show that all of the fertilizers have had an effect on the oat crop of the present year, and that the complete fertilizers have produced the largest yields.

An examination of the total crops of the entire period, as shown in Table F, reveals the fact that what has been found true of this year's oat crop is also true of the combined oat crop and hay crop, i. e. that the largest yields have been produced by complete fertilizers.

Examining the results furnished by the crop of peas, we find that muriate of potash and sulphate of ammonia produced practically no effect; that dissolved bone black alone caused an increase of nearly 13 per cent; and that dissolved bone black and muriate of potash caused an increase of 28 per cent. in the crop, which was not added to by the complete fertilizers. The results obtained from these experiments add weight to the prevailing idea that on an ordinary soil peas do not require nitrogenous manures.

SUMMARY.

The experiment brings out strongly the facts:

(1.) That for the soil on which it was conducted, phosphoric acid and nitrogen are of value as manures.

(2.) That phosphoric acid and potash are the most important fertilizing elements for peas.

THE COMPARATIVE EFFECT OF DIFFERENT AMOUNTS OF FERTILIZERS.

The object of this experiment is to study the limitations of the profitable use of commercial fertilizers. It must be remembered, however, that the work carried out on the college farm does not necessarily have a general application. But in view of the fact of the increasing use of commercial fertilizers, not only in this State but throughout the whole country, it is desirable to point out the existence of limitations, if there are any, that farmers may, in making their plans for carrying on their business, take them into consideration.

Tables G and H give the results of this year's cropping of the plots devoted to this purpose. Table I gives the results for the entire period together with the total value of crop, oats reckoned at 45 cents per bushel, hay at $10.00 per ton and peas at $1.25 per bushel. These values for the crop are liberal. The fertilizers have been reckoned at wholesale prices, dissolved bone black at $24.00 per ton, muriate of potash at 2 cents per pound, and sulphate of ammonia at 3 cents per pound, which is lower than farmers usually pay for these material.

TABLE G.

	No Manure.		Dissolved Bone-black 200 lbs., Muriate of Potash 50 lbs., and Sulphate of Ammonia 60 lbs. per acre.		Dissolved Bone-black 300 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 120 lbs. per acre.		Dissolved Bone-black 400 lbs., Muriate of Potash 150 lbs., and Sulphate of Ammonia 180 lbs. per acre.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Plot 1....	75.5	59.5						
" 7....	50.0	25.5						
" 13....	50.0	25.5						
" 19....	59.0	61.0						
" 25....	55.0	50.0						
" 31....	54.8	20 3						
" 22....			48.5	51.5				
" 28....			62.0	73.0				
" 34....			70.5	69.5				
" 23....					50.0	70.0		
" 29....					63.5	71.5		
" 35....					78.3	71.7		
" 24....							60.0	70.0
" 30....							63.0	67.0
" 36....							68.8	71.2
Average ..	57.0	40.1	60.1	64.7	63.9	71.1	63.9	69.4

TABLE H.

	Fertilizers per acre, in 1886, 1887, and 1889.	Yield of Oats per acre, in bushels.	Yield of Straw per acre, in pounds.	Increase of grain per acre, of manured plots over unmanured plots, in bu.
No manure..........................		38.0	802	
Dissolved bone-black...............	200 lbs.	40.1	1294	2.1
Muriate of potash..................	50 "			
Sulphate of ammonia................	60 "			
Dissolved bone-black...............	300 "	42.6	1422	4.6
Muriate of potash..................	100 "			
Sulphate of ammonia................	120 "			
Dissolved bone-black...............	400 "	42.6	1388	4.6
Muriate of potash..................	150 "			
Sulphate of ammonia................	180 "			

TABLE I.

Crop.	Yield without Manure.	Yield with Dissolved Bone-black 200 lbs., Muriate of Potash 50 lbs., and Sulphate of Ammonia 60 lbs. per acre, in 1886, 1887, and 1889.	Yield with Dissolved Bone-black 300 lbs., Muriate of Potash 100 lbs., and Sulphate of Ammonia 120 lbs. per acre, in 1886, 1887, and 1889.	Yield with Dissolved Bone-black 400 lbs., Muriate of Potash 150 lbs., and Sulphate of Ammonia 180 lbs. per acre, in 1886, 1887, and 1889.
Oats, 1886	54.1 bushels.	57.5 bushels.	69.0 bushels.	68.0 bushels.
Oats, 1887	27.4 "	30.0 "	28.6 "	40.5 "
Hay, 1888	2100 lbs.	2166 lbs.	1767 lbs.	2374 lbs.
Fallow, 1889	....	....	....	....
Peas, 1890	12.7 bushels.	14.9 bushels.	13.7 bushels.	15.9 bushels.
Oats, 1891	38.0 "	40.1 "	42.6 "	42.6 "
Total value of crop	$80.14	$93.25	$89 04	$99.27
Value of crop on manured plots in excess of unmanured plots		$13.11	$8.90	$19.13
Value of fertilizers applied		$15.60	$27 60	$39.60

Table I furnishes the most important data. We find that the excess of the value of the crops on the manured plots over the unmanured plots is not sufficient to pay for the fertilizers in any case. We also find that the smallest amounts come nearer paying for themselves in the increase of the crop. It is probable, however, that the manured plots will continue to give larger yields on account of the applied fertilizers for some years to come. If the season of 1887 had been a favorable one for oats and an average crop produced, it is probable that those plots to which the least amount of fertilizer has been applied would have paid for the fertilizer in the increase of the crop. But it is not probable that either of the other sets of plots would have accomplished this result.

CONCLUSION.

From the investigation this conclusion can be safely drawn. Commercial fertilizers applied at the rate of 300 lbs. to 500 lbs. per acre are more likely to pay for themselves in increased crop produced than larger quantities.

SYSTEMS OF MANURING.

The object of this experiment is, as was stated in last year's report, to compare a system of manuring with stable manure with systems of manuring with commercial fertilizers and with cropping without manure.

A ten acre field was selected and divided into plots of two and one-half acres each, as shown in accompanying diagram.

These plots were cropped two years with hay previous to the application of any manure in order to gain an idea of the relative fertility of the different plots at the beginning of the experiment. The average annual yield of hay was found to be as follows:

	Per Plot.	Per Acre.
Plot 1	6,355 lbs.	2,542 lbs.
" 2	6,040 "	2,416 "
" 3	5,207 "	2.082 "
" 4	6,265 "	2,510 "

Plot 4, which is under cultivation without manure, is taken as a standard from which to reckon the productiveness of the other plots had they been cultivated without fertilization.

The yield of this plot is taken as 100 per cent. The average annual yields of the other plots for the two years they were in hay as compared with this plot are

Plot 1	101 per cent.
" 2	96 "
" 3	80 "
" 4	100 "

In calculating what the probable yield of plots 1, 2 and 3 would be for any year, had no fertilizer been applied, the crop of plot 4 is taken for that year and multiplied by the per cent. of plot 4 which those plots produced while in hay before manuring.

Below is given a diagram of the field with amounts of fertilizers applied in 1890.

EXPERIMENTAL FIELD No. 2.

North.

No. 1. 20 loads (6⅜ cords) Stable Manure per acre.	2½ Acres.
No. 2. 1000 lbs. South Carolina Rock. 66 lbs. nitrate of soda, 16 lbs. sulphate of ammonia, 100 lbs. muriate of potash per acre.	2½ Acres.
No. 3. 500 lbs. Acid South Carolina rock. 66 lbs. nitrate of soda, 16 lbs. sulphate of ammonia. 100 lbs. muriate of potash per acre.	2½ Acres.
No. 4. No Manure.	2½ Acres.

South.

Last year the north half of each plot was in peas and the south half in barley.

Table J shows the yields per one-half plot and per acre of the two crops which have been discussed in detail in the Station Report of 1890.

TABLE J.

Number of plot.	Yield of grain per ½ plot in 1890.	Yield of straw per ½ plot in 1890.	Yield of grain per acre in 1890.	Yield of straw per acre in 1890.
No. 1, N. half.	604 lbs. peas.	1406 lbs. pea straw.	483 lbs. peas.	1205 lbs. pea straw.
S. half.	552 lbs. barley.	2958 lbs. barley "	441 lbs. barley.	2366 lbs. barley "
No. 2, N. half.	453 lbs. peas.	758 lbs. pea straw.	362 lbs. peas.	607 lbs. pea straw.
S. half.	553 lbs. barley.	2527 lbs. barley "	404 lbs. barley.	2092 lbs. barley "
No. 3, N. half.	373 lbs. peas.	843 lbs. pea straw.	300 lbs. peas.	678 lbs. pea straw.
S. half.	542 lbs. barley.	1799 lbs. barley "	434 lbs. barley.	1439 lbs. barley "
No. 4, N. half.	417 lbs. peas.	848 lbs. pea straw.	334 lbs. peas.	678 lbs. pea straw.
S. half.	220 lbs. barley.	1310 lbs. barley "	156 lbs. barley.	1048 lbs. barley "

In the spring of the present year this field was seeded to oats and clover, with the object of getting a clover sod to determine its effect on the insoluble phosphoric acid of the South Carolina rock. A good catch of clover was obtained over the entire field. The result of the oat crop is shown in table K.

TABLE K.

Amount of fertilizers applied per acre in 1890.		Yield of oats per acre in 1891.		Calculated yield per acre without fertilizers.		Calculated gain per acre.	
		Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
Plot 1..	20 loads stable manure	1536 lbs	2282 lbs	1317 lbs	1187 lbs	219 lbs	1095 lbs
Plot 2..	1000 lbs. S. C. rock .... 66 lbs. nitrate of soda......... 16 lbs. sulphate of ammonia.. 100 lbs. muriate of potash	1447 lbs	1534 lbs	1252 lbs	1129 lbs	195 lbs	405 lbs
Plot 3..	500 lbs. acid S. C. rock... .... 66 lbs. nitrate of soda......... 16 lbs. sulphate of ammonia.. 100 lbs. muriate of potash	1523 lbs	1449 lbs	1043 lbs	940 lbs	480 lbs	103 lbs
Plot 4..	No manure............	1304 lbs	1176 lbs				

Last year's report of this work with a barley crop shows that the acid South Carolina rock produced the largest increase in the yield of grain, that stable manure produced the next largest increase and the crude South Carolina rock the least. The result of this year's work shows that the same order is maintained with the oat crop.

Reference to the report of last year shows that peas gave a larger increase with crude South Carolina rock than with acid rock. Too little data has been obtained from which to form sweeping generalizations as to relative ability of different classes of plants to gather their phosphoric acid from crude phosphates. But the writer is inclined to the belief, from the results obtained on this field and on Experimental Field No. 1, together with those obtained in the Leland experiment, a report of which follows, that leguminous plants are better adapted to this purpose than the cereals.

On Peas as a Crop to Precede Grain.

Leguminous plants have been designated as collectors of nitrogen and the cereals as dissipators of nitrogen. Many practical men have generalized from this that all leguminous crops are especially fitted to precede the cereals as collectors of nitrogen for the latter crop. This view of the case is probably correct, when a considerable portion of the leguminous plant is left upon the ground, as with clover. The theory may well be questioned, however, so far as such crops as peas and beans are concerned, they having no large roots to leave in the soil, and with which the entire ærial portion of the plant is removed.

In connection with the experimental work described above a little data bearing on this point has incidentally been obtained.

It has already been noted that the north half of each of the plots on Experimental Field No. 2 was last year cropped with peas and the south half with barley, and that the entire field was cropped with oats this year.

Table L shows the yield of oats and straw per plot and per acre as divided between the north and south half of each plot.

TABLE L.

Number of plot.	Yield of grain per plot in 1891.	Yield of straw per plot in 1891.	Yield of grain per acre in 1891.	Yield of straw per acre in 1891.
No. 1, N. half....	1952 lbs. oats.	3148 lbs. oat straw.	1562 lbs. oats.	2518 lbs. oat straw.
S. half. ..	1888 lbs. oats.	2557 lbs. oat straw.	1510 lbs. oats.	2046 lbs. oat straw.
No. 2, N. half....	1590 lbs. oats.	2150 lbs. oat straw.	1272 lbs. oats.	1720 lbs. oat straw.
S. half....	2029 lbs. oats.	1686 lbs. oat straw.	1623 lbs. oats.	1349 lbs. oat straw.
No. 3, N. half....	1889 lbs. oats.	1921 lbs. oat straw.	1513 lbs. oats.	1537 lbs. oat straw.
S. half....	1918 lbs. oats.	1702 lbs. oat straw.	1534 lbs. oats.	1362 lbs. oat straw.
No. 4, N. half....	1594 lbs. oats.	1456 lbs. oat straw.	1275 lbs. oats.	1165 lbs. oat straw.
S. half....	1667 lbs. oats.	1484 lbs. oat straw.	1334 lbs. oats.	1187 lbs. oat straw.

An examination of this table shows that, with the exception of plot No. 1, to which stable manure was applied, that portion devoted to peas last year gave a smaller yield of oats this year than the portion on which barley was produced last year.

The large difference in the yield between the north and south halves of plot No. 2 can, in part, be explained by the fact that witch grass gained a footing on the north half while the south half was free from it. The yield on the north half was doubtless depressed somewhat on that account. But plots 3 and 4 contained no witch grass and the results obtained from them show nothing favorable to the theory that peas are a better crop to precede a cereal than a cereal.

AN EXPERIMENT TO TEST THE RELATIVE ABILITY OF DIFFERENT CROPS TO OBTAIN PHOSPHORIC ACID FROM CRUDE PHOSPHATES.

This experiment was conducted for the Station by H. L. Leland, of East Sangerville, on a slaty gravel soil. Great credit is due him for the care with which the details of the work were carried out.

A field of three acres, whose dimensions were 20 rods by 24 rods, was divided into three parts, each containing just an acre, with dimensions 8 rods by 20 rods. To the first acre there were applied 500 lbs. of dissolved bone black and 100 lbs. of nitrate of soda; to the second acre there were applied 1000 lbs. of raw South Carolina rock and 100 lbs. of nitrate of soda; to the third acre, 500 lbs. of a Caribbean Sea guano and 100 lbs. of nitrate of soda were applied.

Each acre was then divided into twenty plots one rod wide and eight rods long, containing one-twentieth of an acre, and seeded as shown in the opposite diagram:

	FIRST ACRE.	SECOND ACRE.	THIRD ACRE.
Plot.	500 lbs. dissolved bone-black and 100 lbs. nitrate of soda per acre.	1000 lbs. South Carolina rock, and 100 lbs. nitrate of soda per acre.	500 lbs. Caribbean Sea guano and 100 lbs. nitrate of soda per acre.
1	Clov	Clover.	Clover.
2	Oats.	Oats.	Oats.
3	Peas.	Peas.	Peas.
4	Turnips.	Turnips.	Turnips.
5	Wheat.	Wheat.	Wheat.
6	Beans.	Beans.	Beans.
7	Potatoes.	Potatoes.	Potatoes.
8	....	....	....
9	Corn.	Corn.	Corn.
10	Barley.	Barley.	Barley.
1*d*	Clover.	Clover.	Clover.
2*d*	Oats.	Oats.	Oats.
3*d*	Peas.	Peas.	Peas.
4*d*	Turnips.	Turnips.	Turnips.
5*d*	Wheat.	Wheat.	Wheat.
6*d*	Beans.	Beans.	Beans.
7*d*	Potatoes.	Potatoes.	Potatoes.
8*d*	....	....	....
9*d*	Corn.	Corn.	Corn.
10*d*	Barley.	Barley.	Barley.

24 Rods.

20 Rods.

Mr. Leland writes that the drought from the middle of May to the last of June seriously affected the crop. A neighboring farmer on land adjoining obtained only ten bushels of oats per acre.

The crops of oats, barley, wheat, peas and beans were so small that they were weighed without threshing. The corn was destroyed by grubs and was counted an entire failure.

The following table shows the yields of the various plots and the amounts and kinds of fertilizers used:

Crop.		500 lbs. dissolved bone-black and 100 lbs. nitrate of soda per acre.	1,000 lbs. South Carolina rock and 100 lbs. nitrate of soda per acre.	500 lbs. Caribbean Sea guano and 100 lbs. nitrate of soda per acre.
Plot 1..	Clover . .	Fair.	Best at close of season.	Very poor.
" 2..	Oats . . .	Total crop 115 lbs.	Total crop 80 lbs.	Total crop 75 lbs.
" 3..	Peas . . .	" " 105 "	" " 110 "	" " 51 "
" 4..	Turnips .	351 "	369 "	Failure.
" 5..	Wheat . .	Total crop 120 lbs.	Total crop 105 "	Total crop 65 lbs.
" 6..	Beans . .	" " 63 "	" " 62 "	" " 54 "
" 7..	Potatoes .	228 "	210 "	153 "
" 8..	. . .	. . . .	. . . .	. . . .
" 9..	Corn . . .	Failure.	Failure.	Failure.
" 10..	Barley . .	Total crop 80 lbs.	Total crop 75 lbs.	Total crop 64 lbs.
" 1*d*.	Clover . .	Fair.	Best at close of season.	Very poor.
" 2*d*.	Oats	Total crop 111 lbs.	Total crop 83 lbs.	Total crop 70 lbs.
" 3*d*.	Peas . . .	" " 97 "	" " 103 "	" " 52 "
" 4*d*	Turnips .	340 "	361 "	Failure.
" 5*d*.	Wheat . .	Total crop 119 "	Total crop 102 "	Total crop 61 "
" 6*d*.	Beans . .	" " 66 "	" " 72 "	" " 43 "
" 7*d*.	Potatoes .	223 "	211 "	146 "
" 8*d*.	. . .	. . . .	. . . .	. . . .
" 9*d*.	Corn . . .	Failure.	Failure.	Failure.
" 10*d*.	Barley . .	Total crop 77 lbs.	Total crop 78 lbs.	Total crop 62 lbs.

An examination of the yields of the different crops shows that the dissolved bone black has given with the majority of them the largest return and the Caribbean Sea guano the least.

With peas and turnips South Carolina rock seems to have been more effective than dissolved bone black. This point is brought out quite sharply. The fact that turnips respond to manuring with some crude phosphates has been noted by other experimenters.

The results obtained in this experiment with South Carolina rock on peas agree very closely with the results obtained from all other experiments made by the Station covering this point.

GROWING MIXED GRAINS COMPARED WITH GROWING GRAINS SEPARATELY.

In accordance with the recommendation of the Station Council, trials have been made to test the advantages of growing wheat and oats mixed as compared with growing them separately. Six plots were measured off, 43.6 feet by 240 feet, on land that had been plowed the previous fall and manured at the rate of five cords of stable manure per acre. The seed was sown broadcast May 7th and crop harvested August 24th.

The following table shows the arrangement of the plots, the amount of seed applied and the yield per plot and per acre.

Number of plot.	Seed per plot.	Yield of grain per plot.	Yield of straw per plot.	Yield of grain per acre.	Yield of straw per acre.
1	12 lbs. oats................	451.5 lbs.	563.5 lbs.	2052 lbs.	2561 lbs.
2	8 lbs. oats. 8 lbs. wheat...	367.0 "	593.0 "	1667 "	2696 "
3	24 lbs. wheat..............	314.5 "	515.5 "	1429 "	2343 "
4	12 lbs. oats................	405.0 "	485.0 "	1841 "	2204 "
5	8 lbs. oats, 8 lbs wheat...	343.5 "	546.5 "	1561 "	2484 "
6	24 lbs. wheat..............	307.0 "	583.0 "	1391 "	2650 "

The trial is decidedly in favor of oats separately, as compared with oats and wheat mixed, and oats and wheat mixed, as compared with wheat alone.

These results are in opposition to the teachings of many of our best farmers. A few years ago similar trials were made on the college farm of mixtures of oats and peas which resulted in showing that a larger number of pounds of peas could be produced alone than of a mixture of oats and peas, and that more pounds of the mixture of oats and peas than of oats alone.

CONCLUSION.

The conclusion of the writer is that the crop that yields the largest number of pounds per acre when grown alone will not be benefited by mixing with a crop that produces a less number of pounds per acre.

TRIALS OF SPRING AND FALL MANURING.

On a section of a field, lying west of Experiment Field No. 2, two plots were laid off, one of which was manured in the fall at the rate of five cords of stable manure per acre, and the other manured at the same rate in the Spring. The plots, owing to the shape of the field, are of unequal size but quite uniform in character of soil. On account of the variation in size the yields per plot do not show the relative effect of the manure; but the yields per plot have been calculated per acre and are shown on the following table.

These plots were sown to oats May 2 and harvested August 24.

	Dimensions of plots.	Time of manuring.	Yield of grain per plot.	Yield of straw per plot.	Yield of grain per acre.	Yield of straw per acre.
Plot 1.	143 ft.x84 ft.....	Fall........	395.5 lbs.	654.5 lbs.	1327 lbs.	2190 lbs.
Plot 2.	161 ft.x74 ft.....	Spring.....	411.5 lbs.	593.5 lbs.	1507 lbs.	2175 lbs.

The Spring manuring has given the largest yield of grain, and the Fall manuring the largest yield of straw per acre. At some future time this work will be repeated.

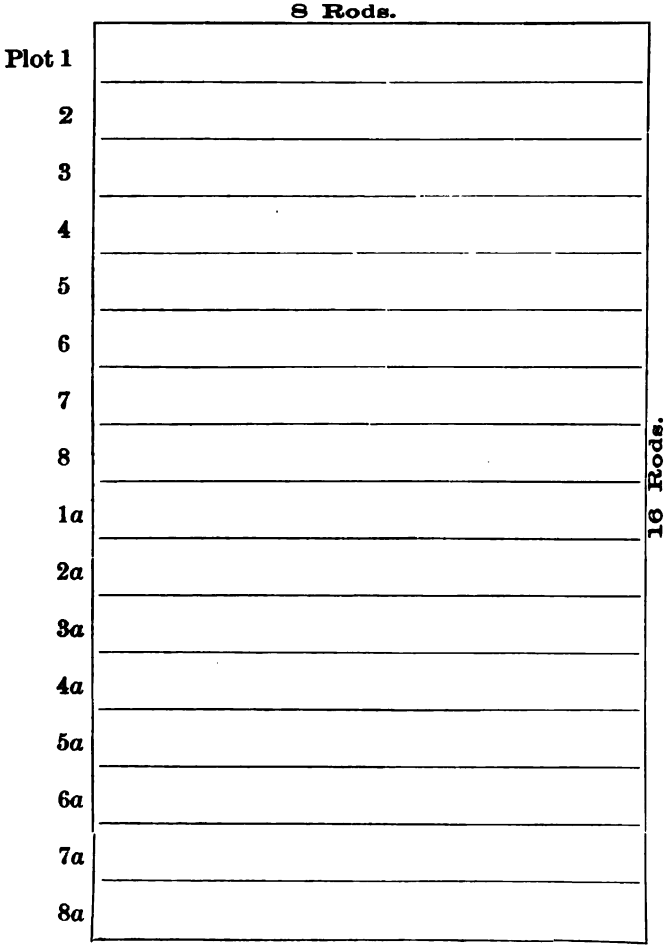
FARMERS' EXPERIMENTS.

It has been the policy of the Station to encourage farmers in studying the application of well known facts in connection with plant growth and soils to the business of producing crops. To this end experimental sets of fertilizers have been sent from time to time to farmers who desired to undertake work of this kind. Eight such sets were shipped to farmers last Spring. Reports have been received from five of them which are of local interest in the neighborhoods where the experiments were carried out.

These sets of fertilizers supplied phosphoric acid, potash and nitrogen, separately, and in various combinations, and were designed to test the ability of the soil to supply one or more of these substances to the crop in such quantities as to render their application superfluous or unprofitable.

Each experiment involved the cultivation of sixteen one-twentieth acre plots as shown in the diagram below.

The plots 1*a* to 8*a* are duplicates of plots 1 to 8. The kinds and quantities of fertilizers used on each plot are indicated in the report of each experiment. Dissolved bone black furnishes phosphoric acid, nitrate of soda, nitrogen, and muriate of potash, potash.



EXPERIMENT OF H. C. TOWSAND, FORT FAIRFIELD.

Crop, potatoes, planted May 23 in checks 32 inches each way, making 288 hills per plot. Whole seed was used, just below market size. Rust struck the tops August 12 which greatly reduced the yield. Potatoes dug and weighed Sept. 26-29. Below are given the results:

Fertilizers applied.	Amount of fertilizer per acre.	No. of plot.	Weight of crop in pounds.	No. of plot.	Weight of crop in pounds.	Average yield of combined plots per acre.
	lbs.					bush.
Dissolved bone-black	500	1	578	1*a*	564	190.3
Nitrate of soda	150					
Muriate of potash	100					
Dissolved bone-black	500	2	511	2*a*	597	184.7
Muriate of potash	100					
Dissolved bone-black	500	3	516	3*a*	559	179.3
Nitrate of soda	150					
Dissolved bone-black	500	4	455	4*a*	503	159.7
Muriate of potash	100	5	408	5*a*	440	141.3
Nitrate of soda	150					
Nitrate of soda	150	6	418	6*a*	415	138.8
Muriate of potash	100	7	370	7*a*	421	131.8
No manure	....	8	335	8*a*	374	118.2

The table below shows the increase of crop on manured plots over unmanured plots calculated per acre, and the cost of fertilizers used, on the basis of dissolved bone black at $24.00 per ton, muriate of potash at 2 cents per pound and nitrate of soda at 2 cents per pound, also cost of increase per bushel.

Plots.	Increase in crop per acre due to fertilizers.	Cost of fertilizer per acre.	Cost of increase per bushel.
1 and 1*a*	72.1 bushels.	$11.00	15.2 cents.
2 and 2*a*	66.5 "	$8.00	12.0 "
3 and 3*a*	61.3 "	$9.00	14.3 "
4 and 4*a*	41.5 "	$6.00	14.5 "
5 and 5*a*	23.1 "	$5.00	21.2 "
6 and 6*a*	20.6 "	$3.00	14.6 "
7 and 7*a*	13.6 "	$2.00	14.7 "
8 and 8*a*			

In this experiment all of the fertilizers caused an increase in the crop but the combination of dissolved bone black and muriate of potash produced the increase at the least cost per bushel.

EXPERIMENT OF F. A. HERRICK, EASTON.

Crop, potatoes, planted June 1 by hand, 5 rows to a plot and 50 hills in a row. No misfortune happened to the crop except missing hills. As the missing hills varied with the different plots, in the table the yields are calculated for 250 hills per plot.

Fertilizers applied.	Amount of fertilizers per acre in lbs.	No. of plot.	Weight of crop per plot in lbs.	No. of plot.	Weight of crop per plot in lbs.	Average yield of combined plots per acre, bush.
Dissolved bone-black	500	1	398	1*a*	413	135.3
Nitrate of soda	·150					
Muriate of potash	100					
Dissolved bone-black	500	2	319	2*a*	413	122.0
Muriate of potash	100					
Dissolved bone-black	500	3	363	3*a*	408	128.5
Nitrate of soda	150					
Dissolved bone-black	500	4	310	4*a*	330	106.7
Muriate of potash	100	5	161	5*a*	181	57.0
Nitrate of soda	150					
Nitrate of soda	150	6	126	6*a*	156	47.0
Muriate of potash	100	7	211	7*a*	151	60.3
No manure	....	8	215	8*a*	165	63.3

Table showing increase of crop on manured plots over unmanured plots and cost of increase per bushel at wholesale prices quoted above for fertilizers.

Plots.	Increase of plot per acre due to fertilizers.	Cost of fertilizers per acre.	Cost of increase per bushel.
1 and 1*a*	72.0 bushels.	$11.00	15.3 cents.
2 and 2*a*	58.7 "	$8.00	13.6 "
3 and 3*a*	65.2 "	$9.00	13.8 "
4 and 4*a*	43.4 "	$6.00	13.8 "
5 and 5*a*	—6.3 "	$5.00	
6 and 6*a*	—16.3 "	$3.00	
7 and 7*a*	—3.0 "	$2.00	
8 and 8*a*			

In this experiment nitrate of soda and muriate of potash mixed and separately seems to have worked absolute harm to the crop, though when combined with dissolved bone black they produced an increase in the crop. So far as cost of increase per bushel is concerned, the results are slightly in favor of dissolved bone black and muriate of potash.

EXPERIMENT OF GEO. INGRAHAM, HOULTON.

Crop, potatoes; on clay loam, hill land; in grass previous season; cut about one-half ton of hay per acre; plowed in Fall of 1890; ground well harrowed; furrowed with a horse hoe at time of planting; fertilizers drilled in the furrow and well mixed with the soil before dropping the seed; planted to Beauty of Hebrons, 10 bushels per acre. The rust struck the vines early in the season and at the time of digging about one-half of the crop proved rotten. The table below shows the yields of sound potatoes only.

Fertilizers applied.	Amount of fertilizers per acre in pounds.	No. of plot.	Weight of crop per plot in lbs.	No. of plot.	Weight of crop per plot in lbs.	Average yield of combined plots per acre, bush.
Dissolved bone-black	500	1	457	1*a*	461	153.0
Nitrate of soda	150					
Muriate of potash	100					
Dissolved bone-black	500	2	473	2*a*	459	155.3
Muriate of potash	100					
Dissolved bone-black	500	3	458	3*a*	470	154.7
Nitrate of soda	150					
Dissolved bone-black	500	4	488	4*a*	465	158.8
Muriate of potash	100	5	433	5*a*	427	143.2
Nitrate of soda	150					
Nitrate of soda	150	6	422	6*a*	430	142.0
Muriate of potash	100	7	428	7*a*	440	144.7
No manure	....	8	215	8*a*	261	78.0

Table showing increase of crop on manured plots ove. unmanured plots and cost of increase per bushel at wholesal prices quoted above for fertilizers.

Plots.	Increase of crop per acre due to fertilizers.	Cost of fertilizers per acre.	Cost of increase per bushel.
1 and 1*a*	75.0 bushels.	$11.00	14.6 cents.
2 and 2*a*	77.3 "	$8.00	10.3 "
3 and 3*a*	76.7 "	$9.00	11.7 "
4 and 4*a*	80.8 "	$6.00	7.4 "
5 and 5*a*	65.2 "	$5.00	7.6 "
6 and 6*a*	64.0 "	$3.00	4.7 "
7 and 7*a*	66.7 "	$2.00	3.0 "
8 and 8*a*			

In this experiment Mr. Ingraham judged that one-half of the potatoes were rotten and reported the weight of the sound ones only, so that no accurate estimate can be made of the effect of the fertilizers. All of the fertilizers increased the crop largely, however. The cost of the increase is least with muriate of potash, while the largest crop was produced with dissolved bone black.

EXPERIMENT OF CHARLES S. POPE, MANCHESTER.

The crop grown was barley. The combined weights of the crops on the duplicate plots are given so that the weights represent the grain produced on one-tenth of an acre instead of a twentieth.

Fertilizers applied.	Amount of fertilizers per acre in lbs.	No. of plot.	Weight of grain in lbs.	Weight of straw in lbs.	Yield of barley per acre, bush.
Dissolved bone-black	500	1 and 1*a*	159	260	33.1
Nitrate of soda..................	150				
Muriate of potash	100				
Dissolved bone-black.............	500	2 and 2*a*	145	215	30.2
Muriate of potash	100				
Dissolved bone-black	500	3 and 3*a*	138	216	26.7
Nitrate of soda..................	150				
Dissolved bone-black.............	500	4 and 4*a*	109	176	22.7
Muriate of potash	100	5 and 5*a*	91	172	19.0
Nitrate of soda	150				
Nitrate of soda	150	6 and 6*a*	73	165	15.2
Muriate of potash	100	7 and 7*a*	71	168	14.8
No manure.......................	....	8 and 8*a*	61	147	12.7

Table showing increase in barley crop on manured plots over unmanured plots and cost of increase per bushel at wholesale prices quoted above.

Plots.	Increase of crop per acre due to fertilizers.	Cost of fertilizer per acre.	Cost of increase per bushel.
1 and 1*a*.......	20.4 bushels.	$11.00	55 cents.
2 and 2*a*.......	17.5 "	$8.00	46 "
3 and 3*a*.......	14.0 "	$9.00	64 "
4 and 4*a*.......	10.0 "	$6.00	60 "
5 and 5*a*.......	6.3 "	$5.00	79 "
6 and 6*a*.......	2.5 "	$3.00	120 "
7 and 7*a*.......	2 1 "	$2.00	95 "
8 and 8*a*.......			

In this experiment dissolved bone black and muriate of potash produced the increase in crop at the least cost per bushel, while dissolved bone black, muriate of potash and nitrate of soda caused the largest gain in crop.

EXPERIMENT OF I. O. WINSLOW, ST. ALBANS.

Crop, corn; soil, gravelly loam; plots, one-thirtieth of an acre instead of one-twentieth; crop weighed in the ear with the husks on.

Fertilizers applied.	Amount of fertilizers per acre in lbs.	No. of plot.	Weight of corn per plot in ears.	No. of plot.	Weight of corn per plot in ears.	Average weight of corn per plot in ears.
			lbs.		lbs.	lbs.
Dissolved bone-black	750	1	180	1*a*	240	210
Muriate of potash	150					
Nitrate of soda	225					
Dissolved bone-black	750	2	175	2*a*	245	210
Muriate of potash	150					
Dissolved bone-black	750	3	93	3*a*	156	130
Nitrate of soda	225					
Dissolved bone-black	750	4	71	4*a*	135	103
Muriate of potash	150	5	202	5*a*	221	212
Nitrate of soda	225					
Nitrate of soda	225	6	121	6*a*	69	95
Muriate of potash	150	7	194	7*a*	92	143
No manure		8	77	8*a*	68	73

Table showing the yield of corn on the ear, in the husk, on manured plots over unmanured plots, together with the cost of fertilizers at wholesale prices quoted above.

Plots.	Increase of crop per acre due to fertilizers.	Cost of fertilizers per acre.
1 and 1*a*	2055 lbs.	$16.50
2 and 2*a*	2055 "	12.00
3 and 3*a*	855 "	13.50
4 and 4*a*	450 "	9.00
5 and 5*a*	2085 "	7.50
6 and 6*a*	229 "	4.50
7 and 7*a*	850 "	3.00
8 and 8*a*		

In this experiment nitrate of soda and muriate of potash gave not only the largest yield but produced the increase in crop at the least expense for fertilizers. Muriate of potash and dissolved bone black gave the same yield as muriate of potash, nitrate of soda and dissolved bone black.

These experiments demonstrate that commercial fertilizers may be used to great advantage by all of the experimenters. They also show that in order to obtain the greatest profit they must be used with a knowledge of what the soil can furnish as well as the requirements of the crop.

In view of the fact, that in four out of five of these experiments the increase in the crop was produced at least expense with either potash, or phosphoric acid, or a combination of the two, it would be well for the experimenters to continue their studies of the effect of application of those materials in a rotation of crops in which the clover has a place, relying on the clover to keep up the nitrogen supply. In the fifth experiment, in which not only the largest crop, but the crop in which the increase was produced at least expense, came from a manuring with muriate of potash and nitrate of soda, it would be advisable to try an experiment to see if the clover in rotation could not be made to take the place of the nitrate of soda.

REPORT OF METEOROLOGIST.

PRESIDENT FERNALD, METEOROLOGIST TO THE STATION.

MAINE EXPERIMENT STATION.

Lat, 44°, 54', 2", N. Long, 68°, 40', 11", W.

In the meteorological work undertaken by the Experiment Station, the object sought is not so much the observing and reporting of general atmospheric phenomena as the careful study of the special meteorological conditions which are more or less intimately connected with practical agriculture.

A reliable determination of these conditions from which safe deductions can be made, necessarily involves observations continued through a series of years.

Accordingly in commencing the work of observation, a plan was formed which has been strictly adhered to during the past three years.

This report contains a summary of results afforded by about thirty thousand independent observations. Under each division of the subject here considered, the observations of the past year are continuous to those of the two preceding years.

Since the instruments have remained unchanged in position during the three years under notice, I draw freely from my former reports, in presenting the arrangement of instruments and the other needful descriptive or explanatory data.

The most of the instruments employed were manufactured by H. J. Green of Brooklyn, N. Y. Mr. Robert H. Fernald of Orono, has been observer during the three years that this work has been carried on. In this report the results of observations made during the years 1889, 1890, and 1891, are combined.

The several problems considered appear in definite order, in the following pages. The first to which attention has been given, is a determination of the percentage of moisture in forest as compared with that in open field.

The arrangement of instruments for this investigation is herewith submitted.

Hygrometer No. 1 is placed in a wooden stand constructed for thermometrical instruments and located in the open field remote from buildings. Hygrometer No. 2 also is enclosed in a wooden box, perforated to allow a free circulation of air, and located also in the open field. Hygrometer No. 3 is also enclosed in a perforated box attached to a tree in a moderately dense forest. Hygrometer No. 4 is placed in a similar box attached to a tree in a portion of the forest a little more open than that in which No. 3 is located, but near which is a running brook except during the driest part of the summer.

Each hygrometer is about four feet above the surface of the ground. Readings are taken three times daily, at 7 A. M., at 1 P. M., and at 7 P. M., local time.

Observations were commenced April 5, 1889 and they have been continued through the growing seasons of 1889, 1890, and 1891.

The monthly averages are given in the following tables on the scale of 100.

PERCENTAGES OF MOISTURE.

HYGROMETER NO. 1.—IN OPEN FIELD.

	1889.			1890.			1891.			
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	Mean
April,	81	53	66	74	50	58	85	61	67	66
May,	84	60	71	81	62	74	82	57	67	71
June,	88	67	81	83	72	75	83	62	71	76
July,	85	65	75	85	74	79	87	61	72	76
August,	95	70	80	90	63	77	89	67	83	79
September,	93	68	83	93	76	85	92	67	84	82
October,	94	66	79	90	62	79	90	63	80	78
Mean results,	89	64	76	85	66	75	87	63	75	76

HYGROMETER NO. 2.—IN OPEN FIELD.

	1889.			1890.			1891.			
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	Mean
April,	78	52	65	70	46	56	84	62	70	65
May,	80	53	68	78	61	74	80	55	68	68
June,	84	66	74	78	68	75	82	62	73	73
July,	79	60	69	80	63	71	86	62	75	72
August,	87	67	75	88	62	73	87	65	80	76
September,	91	60	81	91	67	83	91	67	85	80
October,	93	66	81	91	62	79	91	65	82	79
Mean results,	85	61	72	82	61	73	86	63	76	73

HYGROMETER NO. 3.—IN FOREST.

	1889.			1890.			1891.			
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	Mean
April,	81	62	69	78	61	69	90	73	77	76
May,	83	63	73	87	74	81	86	68	75	77
June,	89	80	84	87	77	82	88	81	84	84
July,	94	86	91	93	85	83	92	80	85	90
August,	91	89	93	94	80	84	95	81	88	88
September,	96	88	92	96	87	92	95	81	92	91
October,	96	90	90	96	86	90	92	77	86	89
Mean results,	90	80	85	90	79	83	91	77	84	85

HYGROMETER NO. 4.—IN FOREST.

	1889.			1890.			1891.			
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	Mean
April,	83	65	77	79	60	71	91	74	82	76
May,	89	66	80	88	73	84	87	69	78	79
June,	92	81	86	89	77	84	90	74	82	84
July,	93	79	87	91	79	85	93	79	86	86
August,	95	86	91	91	78	85	96	78	90	88
September,	96	83	90	97	86	92	96	79	92	90
October,	96	80	90	94	80	89	92	76	87	87
Mean results,	92	77	86	90	76	84	92	75	85	84

PERCENTAGES OF MOISTURE.

RESULTS FOR 1889, 1890, AND 1891, COMBINED.

	7 A. M.	1 P. M.	7 P. M.	Mean
Hygrometer No. 1, in open field,	87	64	75	75
" " 2, " " "	84	62	74	73
" " 3, in forest,	90	79	84	84
" " 4, " "	91	76	85	84

Regarding the mean results from hygrometers Nos. 1 and 2 as indicating percentages for the open field, we have the following summary of results:

	7 A. M.	1 P. M.	7 P. M.	Mean
Percentages of moisture, open field,	85	63	74	74

Regarding the mean results from hygrometers No. 3 and 4 as indicating percentages for forests only moderately dense, we have the following summary results:

	7 A. M.	1 P. M.	7 P. M.	Mean
Percentages of moisture, forest,	90	78	84	84

Comparing results, open field and forest, we have excess of moisture in forest above that in open field expressed in percentages.

7 A. M.	1 P. M.	7 P. M.	Mean
5	15	10	10

It thus appears from observations covering the period of growth of three years, that the excess of moisture in forest above that of open field in the morning, amounts to but 5 per cent., while in the middle of the day it rises to 15 per cent., and at night-fall drops down to 10 per cent., and that the mean excess for the day is 10 per cent. In a very dense forest the percentage of excess would undoubtedly rise much higher. The presence of patches of forest in any region exerts a marked influence on the hygroscopic conditions of the atmosphere, and this condition, in turn, is an important factor in the growth of vegetation.

SOIL TEMPERATURES.

In this investigation a knowledge of the temperature of the soil at different depths, during the growing season, is sought, and ultimately the law which represents the rate of change of temperature at different depths.

The periods covered by the experiment are from May 1 to Nov. 1, 1889, from April 1 to Nov. 1, 1890, and from April 1 to Nov. 1, 1891, with thermometers placed in the soil to the depths of 1, 3, 6, 9, 12, 24 and 36 inches.

The thermometers have been allowed to remain in place during the winters intervening between the periods of observation.

Their location is in the open field, near hygrometer No 2, in the tract of land assigned to the Station for experimental purposes and devoted to farm experiments. The character of the soil is regarded, therefore, as representative of that on which the field experiments by the Station are carried on.

A summary of results for the three seasons by monthly averages is given in the annexed tables.

SOIL THERMOMETERS—1889.

	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
May	51.77	62.92	59.20	51.50	60.33	59.70	52.92	55.21	57.04	53.49	53.31	55.44	52.46	52.15	53.21	48.84	49.06	49.01	46.28	46.42	46.48
June	61.94	71.54	67.56	61.38	69.62	67.76	61.85	68.43	65.35	62.07	62.27	63.51	61.26	61.10	61.79	57.23	57.43	57.41	54.36	54.54	54.52
July	63.41	72.10	68.89	63.10	70.86	69.54	64.25	66.51	67.48	64.93	65.15	66.27	64.30	64.02	64.29	60.99	61.14	61.03	58.50	58.62	58.57
August	61.18	69.59	66.90	61.75	68.91	68.01	62.90	64.83	66.01	59.82	63.88	65.01	63.31	63.10	63.31	60.96	61.10	60.97	59.16	59.31	59.23
September	57.11	61.56	61.45	57.74	63.01	62.89	59.47	60.25	61.29	60.29	60.20	60.93	60.30	60.21	60.04	59.42	59.51	59.36	58.40	58.51	58.37
October	42.80	43.59	45.50	43.80	47.31	46.72	46.06	46.48	47.12	47.21	46.97	47.32	48.17	47.83	47.85	50.63	50.65	50.54	51.66	51.66	51.61
Mean	56.37	63.55	61.58	56.54	63.34	62.44	57.91	60.28	60.71	57.97	58.63	59.75	58.30	58.06	58.41	56.34	56.48	56.39	54.84	54.73	54.79
Mean temperature for six months	60.50°			60.77°			59.63°			58.78°			58.26°			56.40°			54.79°		

SOIL THERMOMETERS—1890.

	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
April	33.74	40.35	36.89	36.53	38.12	37.11	34.32	34.55	35.13	33.56	34.09	34.29	34.57	34.55	34.75	34.81	34.83	34.95	35.31	35.39	35.37
May	50.38	54.80	51.53	47.63	54.67	53.40	49.40	50.26	51.49	49.29	49.27	49.72	48.80	48.68	48.82	45.72	45.55	45.84	43.27	43.72	43.77
June..	56.06	60.05	59.68	55.91	60.44	60.07	56.11	56.78	57.55	55.85	55.95	56.32	55.99	55.95	55.82	53.52	53.18	53.27	50.85	50.94	50.96
July	62.82	64.69	64.03	62.66	66.93	66.81	65.91	64.11	64.87	62.85	62.95	63.88	62.70	62.60	62.78	58.77	58.84	58.77	56.25	56.28	56.34
August...........	61.80	68.20	67.28	62.15	67.60	67.41	63.69	65.08	66.26	63.91	64.16	64.83	63.87	63.84	63.91	61.72	62.09	61.34	59.43	59.40	59.39
September	56.51	59.83	59.43	57.44	58.93	59.62	58.21	58.56	59.34	58.36	58.30	58.59	58.73	58.58	58.56	58.15	58.43	58.37	57.73	58.05	57.65
October	45.37	47.17	46.67	45.77	47.16	46.76	47.09	47.10	47.23	47.40	47.32	47.66	48.81	48.72	48.59	51.08	50.97	50.86	52.07	52.04	52.00
Mean.............	52.38	56.44	55.07	52.58	56.29	55.88	53.54	53.78	54.55	53.03	53.15	53.61	53.35	53.27	53.32	51.97	51.99	51.93	50.70	50.83	50.78
Mean temperature for seven months,	° 54.63			° 54.92			° 53.96			° 53.26			° 53.31			° 51.96			° 50.77		

SOIL THERMOMETERS—1891.

	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
April............	37.70	42.48	42.34	37.69	42.32	42.41	39.03	39.81	41.40	37.64	37.68	39.93	38.80	38.69	38.58	36.87	36.96	37.01	37.46	37.53	37.53
May............	46.54	54.03	52.93	54.31	53.73	52.87	47.49	49.27	51.24	47.83	48.22	49.36	47.64	47.63	47.90	45.00	45.14	45.20	43.78	43.49	43.50
June............	59.18	65.42	64.53	59.10	64 80	64.21	59.43	60.40	61.73	59.23	58.96	59.67	58.79	58.37	58.60	54.00	54.12	54.11	51.25	51.35	51.37
July.	62.70	68.59	67.44	62.78	67.56	67.10	63.08	64.23	65.18	63.17	63.18	62.85	62.39	62 14	62.44	58.16	58.25	58.26	55.75	55.82	55.82
August...........	62.45	69.07	67.46	62.59	68.03	67.45	63.98	64.97	66.62	63.93	63.99	64.99	63.80	63.59	63.91	60.72	60.83	60.76	58.66	58.73	58.37
September	58.82	62.88	62.41	59.00	62.85	62.55	60.43	60.99	62.00	60.57	60.48	61.21	60.77	60.60	60.73	59.67	59.70	59.65	58.53	58.61	58.36
October	46.03	48.78	47.94	46.20	48.86	48.22	48.20	48.54	48.81	48.78	48.57	49.17	50.02	49.86	49.77	52.74	52.67	52.53	53.61	53 58	53.50
Mean......... ..	53.35	58.75	57.86	54.52	58.31	57.83	54.52	55.46	56.71	54.45	54.44	55.34	54.60	54.41	54.56	52 45	52.52	52.50	51.29	51.30	51.49
Mean temperature for seven months,	56.65°			56.89°			55.56°			54.74°			54.52°			52.49°			51.36°		

In order that comparisons may be made between soil temperatures at different depths and the air temperatures during the same months and in the same locality, the following tables are added:

THERMOMETER IN THE OPEN AIR.

(Locality the same as that of the soil thermometers.)

1889.

	7 A.M.	1 P.M.	7 P.M.	Mean.
	°	°	°	°
May,	52.95	68.30	59.47	60.24
June,	63.36	74.27	68.07	68.57
July,	65.12	75.75	70.86	70.58
August,	59,97	74.20	66.81	66.99
September,	54.39	70.86	61.55	62.27
October,	37.41	52.80	44.05	44.75
Mean,	55.53	69.36	61.80	62.23

1890.

	7 A.M.	1 P.M.	7 P.M.	Mean.
	°	°	°	°
April,	35.76	49.02	42.55	42.44
May,	49.16	60.60	53.58	54.45
June,	57.95	67.64	62.76	62.78
July,	67.10	76.19	71.85	71.71
August,	61.50	73.78	68.84	68.04
September,	52.04	66.16	58.52	58.91
October,	37.70	53.19	45.63	45.51
Mean,	51.60	63.80	57.68	57.69

1891.

	7 A.M.	1 P.M.	7 P.M.	Mean.
	°	°	°	°
April,	36 33	48.26	43.64	42.74
May,	47.07	61 75	53.30	54.04
June,	58.28	72.42	65.38	65.36
July,	64.08	76.05	68.81	69.65
August,	62.07	74.94	67.47	68.16
September,	56.13	69.72	61.80	62.55
October,	38.11	54.02	45.56	45.90
Mean,	51.72	65.31	57.99	58.34

TABLES SHOWING CHANGES OF TEMPERATURE IN THE SOIL FOR INCREASED DEPTHS.

1889.

Depth of Thermometer.	Mean temperature for 6 mos., May to Oct. inclusive.	Difference in mean temperatures.	Changes in temperature for one inch.
	°	°	°
1 inch	60.50	+0.27	+0.13
3 inches	60.77	—1.14	—0.38
6 inches	59.63	—0.85	—0.28
9 inches	58.78	—0.52	—0.17
12 inches	58.26	—1.86	—0.15
24 inches	56.40	—1.61	—0.13
36 inches	54.79		

1890.

Depth of Thermometer.	Mean temperature for 7 mos., April to Oct. inclusive.	Difference in mean temperatures.	Changes in temperature for one inch.
	°	°	°
1 inch	54.63	+0.29	+0.14
3 inches	54.92	—0.96	—0.32
6 inches	53.96	—0.70	—0.23
9 inches	53.26	+0.05	+0.02
12 inches	53.31	—1.35	—0.11
24 inches	51.96	—1.19	—0.10
36 inches	50.77		

1891.

Depth of Thermometer.	Mean temperature for 7 mos., April to Oct. inclusive.	Difference in mean temperatures.	Changes in temperature for one inch.
	°	°	°
1 inch	56.65	+0.24	+0.12
3 inches	56.89	—1.33	—0.44
6 inches	55.56	—0.82	—0.27
9 inches	54.74	—0.22	—0.07
12 inches	54.52	—2.03	—0.17
24 inches	52.49	—1.13	—0.09
36 inches	51.36		

An examination of the tables shows that the soil responds readily to the daily heat of the sun to the depth of three inches, less readily to the depth of six inches, in a moderate degree only to the depth of nine inches, and very slightly below twelve inches. To the depth of three inches the range between the morning and the midday observations has been as high as fifteen degrees. The mean daily range at the depth of 1 inch during the period of observations was 5°.55; at the depth of three inches, 4°.77; at the depth 6 inches, 2°.00; at the depth of 9 inches, 1°.09, and below 12 inches very slight.

At the depth of 3 inches, the average temperature of the soil was somewhat higher than at the depth of 1 inch. The surface soil averaged about five degrees warmer than the soil 36 inches below the surface.

The rate of reduction of temperature with depth below the layer three inches from the surface is clearly shown in the foregoing tables.

It is interesting to notice how closely the changes in temperature for one inch accord with one another, in the different years, at corresponding depths.

The apparent rate of reduction of temperature with depth is vitiated, however, by the record of the 9-inch soil thermometer. This anomalous record is explained by the fact that at the end of the first season this thermometer was broken and a new one had to be substituted in its place. The contact of the latter with the soil was not precisely the same as that of the former or of the other instruments that had not been disturbed. Judging from the tables, another year will be needed to restore uniformity of condition among the several instruments. This accident, with the resulting error introduced, well illustrates the delicacy of the work carried on by means of the soil thermometers.

Comparing soil temperatures with air temperatures during the three seasons, the following mean results appear: At the depth of 1 inch, the temperature of the soil was lower than that of the air by 2°.16; at the depth of 3 inches, by 1°.89; 6 inches, by 3°.08; 9 inches, by 3°.83; 12 inches, by 4°.06; 24 inches, by 5°.80, and at the depth of 36 inches, by 7°11.

TERRESTRIAL RADIATION.

The heat radiated from the surface of the earth during the night reduces its temperature several degrees below that of the surrounding atmosphere. The amount of this radiation or the consequent reduction of temperature is approximately shown by comparing the readings of a terrestrial radiation thermometer with those of a minimum thermometer. In obtaining data for the comparison given below, the minimum thermometer was four feet above the ground and the terrestrial radiation thermometer was within six inches of its surface. The results are based on monthly averages from May to October inclusive, 1889, from April to October inclusive, 1890, and from April to October inclusive, 1891.

TABLE SHOWING LOSS OF HEAT BY TERRESTRIAL RADIATION.

1889.

	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
	°	°	°	°	°	°	°
Mean of minimum temperatures.	46.63	53.25	55.08	53.65	49.07	33.91	48.50
Mean of Temp. from Ter. Rad. Ther.....	38.48	49.20	50.59	47.66	44.60	28.48	43.17
Loss of heat by radiation.........	8.15	4.05	4.49	5.39	4.74	5.43	5.33

1890.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean
	°	°	°	°	°	°	°	°
Mean of minimum temperatures	29.17	42.52	48.71	53.61	53.52	45.32	36.05	44.13
Mean of Temp. from Ter. Rad. Ther...	19.95	37.10	42.10	44.55	46.25	38.40	27.14	36.50
Loss of heat by radiation.............	8.22	5.42	6.61	9.06	7.27	6.92	9.91	7.63

1891.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean
	°	°	°	°	°	°	°	°
Mean of minimum temperatures. ...	30.22	37.67	49.18	53.15	54.07	49.23	34.95	44.07
Mean of Temp. from Ter. Rad. Ther..	24.45	29.09	40.87	43.94	47.40	42.22	25.60	36.23
Loss of heat by radiation........ ...	5.77	8.58	8.31	9.21	6.67	7.01	9.35	7.84

On cloudy nights the difference in the reading of the two thermometers is small, and on exceptionally clear (dry) nights it is a maximum. The greatest range observed was 19°.5. On the morning of July 2, 1889, the radiation thermometer was the higher, showing that the moist air resting upon the surface of the ground served as a warm blanket, and that the amount of heat absorbed was greater than that radiated. From the table above it appears that the mean radiation for the three seasons was 6°.93.

SOLAR RADIATION.

The temperature of the atmosphere does not indicate the intensity of the sun's heat, as only a small percentage is absorbed as the rays are transmitted through the air. The maximum thermometer in the shade, therefore, does not give the intensity of solar radiation; neither does exposure of an ordinary thermometer to the direct rays of the sun, in consequence of the cooling effects of draughts of air. In order to avoid the effects of currents of air, the *vacuum solar radiation thermometer* has been devised. "This consists of a blackened bulb radiation thermometer inclosed in a glass tube and globe, from which all air is exhausted. Thus protected from the loss of heat which would ensue if the bulb were exposed, its indications are from 20° to 30° higher, than when placed side by side with a similar instrument with the bulb exposed to the passing air." By the use of this instrument the amounts of solar radiation at different places and in different seasons at the same place are rendered comparable. The relations of solar intensity, as distinct from temperature of the air, to the growth and maturity of crops are worthy of careful investigation. High solar intensity maintained through the latter part of the growing season has an important bearing upon the complete ripening of vegetables and fruits and likewise upon their keeping qualities. From the wide range of observations undertaken by Experiment Stations with radiation thermometers, important deductions may reasonably be expected. I subjoin tables of results from the maximum thermometer and the thermometer for solar radiation, expressed in monthly averages.

1889.

	May.	June.	July.	Aug.	Sept.	Oct.	Mean
	o	o	o	o	o	o	o
Mean of readings, Sun Ther.	133.02	134.22	139.55	137.56	122.79	105.86	128.83
Mean of maximum temperatures	67.85	73.45	75.30	73.72	71.23	52.78	69.05
Excess of solar intensity.............	65.17	60.77	64.25	63.84	51.56	53.08	59.78

1890.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean
	o	o	o	o	o	o	o	o
Mean of readings, Sun Ther..	119.15	119.45	128.81	139.37	138.25	114.94	112.52	124.65
Mean of maximum Temp.....	49.37	61.16	68.01	76.53	74.67	62.32	55.61	64.38
Excess of solar intensity	69.82	58.29	60.80	62.84	63.58	49.62	56.92	60.27

1891.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean
	o	o	o	o	o	o	o	o
Mean of readings, Sun Ther..	106.78	119.19	129.44	140.35	129.55	121.65	99.55	120.93
Mean of maximum Temp.....	50.65	62.48	72.17	76.68	75.39	69.84	54.18	65.91
Excess of solar intensity	56.13	56.71	57.27	63.67	54.16	51.81	45.37	55.02

From the above records it appears that the average excess of solar intensity above that given by the maximum thermometer for the growing periods of 1889, 1890, and 1891, was 58°.36.

The season of greatest excess in this regard was that of 1890, a season noted for the perfect maturity of fruits and vegetables.

AMOUNT OF SUNSHINE.

The amount of sunshine as an essential factor in crop production is worthy of observation and record. Observations were commenced May 1, 1890, and the table below furnishes the summary for the six months following and for seven months, April to November, 1891.

BRIGHT SUNSHINE IN HOURS.

1890.

	May.	June.	July.	Aug.	Sep.	Oct.	Mean.
Sunshine,	180	186	216	193	126	133	172
Hours per day, mean,	5.8	6.2	7.0	2.6	4.2	3.3	5.6

1891.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
Sunshine,	174	207	217	259	225	234	154	209
Hours per day, mean,	5.8	6.7	7.2	8.4	7.3	7.8	5.0	6.9

During the period covered by the above table, the average hours of bright sunshine per day were 6.3 or 46 per cent. of the possible amount.

WIND AND RAIN.

The velocity of the wind has been determined by a Robinson's Anemometer, with electrical recording apparatus, attached to the Experiment Station building, and the amount of rain by means of a gauge, signal service pattern, located in the same plat as the soil thermometers.

1889.

	WIND.		RAIN.
	Mean distance travelled per day. Miles.	Velocity per hour. Miles.	Amount. Inches.
April,	253.93	10.58	1.36
May,	189.83	7.91	1.61
June,	171.12	7.13	4.86
July,	200.33	8.34	3.27
August,	139.35	5.81	1.69
September,	198.06	8.25	2.10
October,	194.31	8.09	3.96
Mean,	192.42	8.02	Total, 18.85

1890.

	Wind.		Rain.
	Mean distance travelled per day. Miles.	Velocity per hour. Miles.	Amount. Inches.
April,	241.73	10.07	1.98
May,	235.14	9.79	10.13
June,	230.40	9.60	3.78
July,	166.28	6.95	3.84
August,	187.03	7.65	5.39
September,	155.59	6.45	4.21
October,	189.01	7.85	3.19
Mean,	200.74	8.34	Total, 32.52

1891.

	Wind.		Rain.
	Mean distance travelled per day. Miles.	Velocity per hour. Miles.	Amount. Inches.
April,	210.55	8.77	3.13
May,	206.25	8.59	2.76
June,	182.71	7.61	3.13
July,	185.44	7.73	3.36
August,	169.58	7.07	4.38
September,	162.07	6.75	3.50
October,	191.92	8.00	2.81
Mean,	186.93	7.79	23.07

For the full year 1890, the mean daily velocity of wind was 211.16 miles, and the mean hourly velocity, 8.90 miles; and for the full year 1891, the corresponding velocities were respectively 214.82 miles and 8.95 miles. The rain-fall in May, 1890, amounting to 10.13 inches, was larger than in any other month in twenty-three years.

CONCLUSION.

A summarized report, like that which has been presented, while in proper form for inferring laws and deducing general principles, conveys but little idea of the nature and daily requirements of the meteorological work in progress.

In order that these points may be more definitely apprehended, I append the records for one month of 1891, selecting the month of September.

An examination of the original records discloses much of interest that cannot appear in a condensed summary.

It is by the careful study of observations and records covering a considerable period of time, that general laws pertaining to this subject are discovered, and truths are revealed which are of importance to mankind.

HYGROMETER NO. 1.—IN OPEN FIELD.

SEPTEMBER, 1891.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry bulb.	Wet bulb.	Dew point.	Humidity.	Dry bulb.	Wet bulb.	Dew point.	Humidity.	Dry bulb.	Wet bulb.	Dew point.	Humidity.
1....	52.5	50.4	49	87	60.0	57.5	56	86	54.8	51.3	54	97
2....	52.9	52.0	51	94	64.5	59.6	57	75	61.6	60.2	60	92
3....	49.2	49.2	49.2	100	73.6	64.7	60	62	64.8	63.6	63	94
4....	63.7	62.3	62	92	72.0	61.2	54	54	66.0	63.0	61	85
5....	49.3	47.5	45	87	67.0	57.2	50	54	59.7	56.5	55	82
6....	54.0	53.0	52	94	60.2	60.2	60.2	100	60.0	60.0	60	100
7....	60.0	60.0	60	100	60.4	60.4	60.4	100	60.7	60.7	60.7	100
8....	54.3	52.3	50	88	65.0	57.1	51	61	57.0	52.0	48	71
9....	46.2	45.0	44	91	65.0	55.7	48	55	60.0	53.5	48	65
10....	51.9	50.8	50	94	68.9	58.4	51	53	58.8	55.3	53	81
11....	54.6	54.0	54	97	72.8	60.3	52	48	64.3	60.1	57	78
12....	49.7	49.7	49.7	100	63.6	56.8	52	66	60.6	59.0	59	92
13....	59.8	59.0	58	95	61.8	57.2	54	76	62.0	60.1	59	89
14....	60.0	60.0	60	100	64.0	62.0	61	90	64.4	57.2	52	64
15....	48.4	47.0	45	89	57.7	51.2	46	64	54.3	50.3	46	76
16....	39.4	39.1	38	98	65.1	56.3	49	57	60.0	55.8	53	77
17....	51.5	50.5	50	94	68.4	58.8	52	56	58.9	56.8	56	89
18....	60.2	59.6	59	97	74.2	70.0	68	82	67.6	67.6	67.6	100
19....	55.8	52.3	50	80	67.7	61.7	58	71	66.0	61.0	58	75
20....	55.0	53.0	52	88	70.3	65.9	63	79	58.0	55.8	55	88
21....	57.8	57.0	56	95	74.3	69.2	67	78	63.1	61.1	60	89
22....	57.0	56.3	56	96	72.7	66.8	64	73	62.0	61.0	60	95
23....	56.0	56.0	56	100	71.8	61.2	55	75	59.8	57.9	57	89
24....	50.0	47.3	45	82	62.8	58.0	55	75	61.0	59.0	58	89
25....	58.5	58.5	58.5	100	64.8	72.0	66	54	73.0	68.0	66	78
26....	60.3	55.2	51	73	69.3	56.7	47	45	65.0	57.2	51	62
27....	51.7	51.0	51	96	72.8	62.1	56	54	58.5	54.0	51	75
28....	55.0	55.0	55	100	76.0	69.2	66	71	62.0	60.5	60	92
29....	62.0	61.0	60	95	73.0	67.0	64	73	65.1	63.0	62	90
30....	53.0	45.2	36	53	59.0	48.2	37	44	51.5	47.2	43	73
Means.................				.92				.67				.84
Mean for month.. 0.81												

HYGROMETER NO. 2.—IN OPEN FIELD.

SEPTEMBER, 1891.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry bulb.	Wet bulb.	Dew point.	Humidity.	Dry bulb.	Wet bulb.	Dew point.	Humidity.	Dry bulb.	Wet bulb.	Dew point.	Humidity.
1....	54.5	52.7	52	89	63.1	59.6	57	82	55.9	55.2	55	96
2....	53.6	52.8	52	95	65.9	60.0	56	71	62.7	61.0	61	91
3....	52.7	52.7	52.7	100	74.2	65.1	60	62	65.3	63.9	63	92
4....	65.0	63.2	62	91	75.5	69.0	66	72	67.0	64.0	62	85
5....	53.6	52.0	51	91	69.8	59.8	53	55	59.8	56.2	54	81
6....	54.7	53.5	53	93	61.3	61.3	61.3	100	60.7	60.7	60.7	100
7....	60.6	60.6	60.6	100	60.8	60.8	60.8	100	60.8	60.8	60.8	100
8....	57.8	55.0	53	84	66.0	57.3	51	58	57.0	52.2	48	72
9....	48.6	46.7	45	86	66.8	56.3	48	51	60.0	53.2	47	64
10....	55.4	54.2	53	93	70.0	59.7	52	54	61.7	57.7	55	79
11....	57.2	56.3	55	94	73.6	61.7	54	50	66.3	62.0	59	79
12....	53.0	52.3	52	96	65.4	56.9	50	59	62.3	60.6	60	91
13....	60.2	59.0	58	93	63.7	58.6	56	74	62.5	61.0	61	92
14....	60.5	60.5	60.5	100	65.6	63.4	63	89	61.8	58.6	57	83
15....	49.8	48.5	47	91	59.7	54.0	50	69	55.8	52.6	51	81
16....	44.9	44.9	44.9	100	67.9	59.4	51	60	61.2	57.1	54	78
17....	57.0	55.3	55	90	73.2	68.4	66	79	60.2	58.2	57	89
18....	61.2	60.8	60	97	76.5	73.2	72	86	68.2	68.2	68.2	100
19....	55.8	52.8	51	82	68.4	61.2	57	66	64.2	59.0	56	73
20....	60.3	57.2	55	84	74.3	63.8	57	56	58.7	57.0	57	91
21....	60.0	59.0	58	94	75.4	71.0	68	80	63.7	62.0	52	91
22....	57.8	57.0	56	95	74.0	68.8	67	77	62.8	61.2	61	92
23....	56.7	56.7	56.7	100	72.6	61.9	56	54	57.2	56.0	55	93
24....	50.0	47.0	44	80	65.2	60.0	57	74	61.8	59.5	58	88
25....	59.0	59.0	59	100	85.0	72.3	66	54	73.5	68.0	66	76
26....	60.8	55.9	52	75	69.9	57.2	48	45	63.7	56.0	51	61
27....	52.8	51.3	50	91	75.3	64.7	58	56	61.2	56.8	53	76
28....	55.0	55.0	55	100	78.6	70.8	67	69	61.7	60.4	60	93
29....	62.1	61.6	61	97	75.0	68.3	65	71	65.6	63.7	63	90
30....	53.7	46.4	39	57	59.0	49.9	39	47	50.8	46.3	42	71
Means....................				.91				.67				.85
Mean for month..											0.81	

HYGROMETER NO. 3—IN FOREST.

SEPTEMBER, 1891.

Day.	7 A.M.				1 P.M.				7 P.M.			
	Dry bulb.	Wet bulb.	Dew point.	Humidity.	Dry bulb.	Wet bulb.	Dew point.	Humidity.	Dry bulb.	Wet bulb.	Dew point.	Humidity.
1....	46.9	45.4	44	89	57.5	55.0	54	86	52.8	52.8	52.8	100
2....	50.3	49.8	49	97	62.3	59.1	57	83	59.7	59.0	59	96
3....	48.7	48.7	48.7	100	70.0	64.6	61	74	62.9	61.7	61	94
4....	62.6	42.0	62	97	70.2	68.2	67	90	65.2	64.5	64	96
5....	50.0	49.0	48	93	61.2	68.6	57	87	60.4	59.2	58	93
6....	54.0	53.7	53	98	58.7	58.7	58.7	100	59.8	59.3	59.3	100
7....	59.5	59.5	59.5	100	59.7	59.7	59.7	100	59.8	59.8	59.8	100
8....	52.8	52.2	52	96	62.0	59.1	57	84	57.9	56.4	56	91
9 ...	43.3	42.8	42	96	61.7	57.8	55	79	59.1	56.3	54	84
10 ...	48.3	48.0	47	98	64.0	59.8	57	78	59.8	58.3	58	92
11....	49.6	49.3	49	99	66.7	61.2	58	73	64.0	61.8	61	89
12....	49.9	49.0	48	93	59.6	54.2	50	70	57.8	57.0	56	95
13....	57.6	57.2	57	97	58.6	55.2	53	81	62.3	61.5	60	96
14....	60.3	60.0	59	98	61.8	61.8	61.8	100	59.0	58.2	57	95
15....	48.1	47.8	47	98	56.8	51.9	48	71	55.5	53.3	53	87
16....	41.5	41.3	41	98	58.6	54.0	51	75	57.0	55.4	55	91
17....	49.3	48.3	42	92	62.8	59.2	57	82	60.2	58.2	57	89
18....	59.0	58.2	57	95	71.8	69.2	69	88	65.4	65.1	66.4	100
19....	55.2	53.0	52	87	63.2	55.3	49	60	61.0	57.4	55	81
20....	48.9	48.3	48	96	64.0	59.0	56	74	59.5	59.0	59	97
21....	56.0	55.0	54	94	67.9	65.1	63	86	63.0	62.3	62	96
22....	56.8	56.0	55	95	64.9	62.7	62	89	63.0	61.2	60	90
23....	55.8	55.8	55.8	100	67.8	63.3	61	78	59.3	57.0	55	87
24....	49.3	48.1	47	92	60.0	58.0	57	89	58.3	57.0	56	92
25....	47.7	47.7	47.7	100	79.2	72.2	69	71	74.5	71.0	70	84
26....	60.4	57.0	54	81	65.8	58.2	53	63	62.9	58.8	56	79
27....	50.6	50.3	50	98	67.9	62.1	58	72	57.8	55.6	55	88
28....	54.4	54.4	54.4	100	70.8	68.0	67	87	61.5	60.0	60	92
29....	61.3	60.6	60	96	71.1	68.0	67	86	65.4	63.8	63	92
30....	51.6	50.0	49	90	58.0	51.0	45	61	52.0	49.0	46	81
Means.................				.95				.81				.92
Mean for month..											0.89	

HYGROMETER NO. 4—IN FOREST.

SEPTEMBER, 1891.

Day.	7 A.M.				1 P.M.				7 P.M.			
	Dry bulb.	Wet bulb.	Dew point.	Humidity.	Dry bulb.	Wet bulb.	Dew point.	Humidity.	Dry bulb.	Wet bulb.	Dew point.	Humidity.
1....	47.0	45.8	45	92	57.7	54.9	53	84	53.5	53.5	53.5	100
2....	50.1	49.4	49	96	62.7	59.2	57	82	60.6	59.8	59	95
3....	47.6	47.6	47.6	100	69.3	64.0	60	75	63.4	62.1	61	93
4....	63.0	62.2	61	96	71.2	67.3	65	81	66.8	64.8	64	95
5....	50.0	48.8	48	92	62.3	57.5	53	75	60.0	59.0	58	94
6....	54.2	53.8	53	97	59.0	59.0	59	100	59.1	59.1	59.1	100
7....	59.8	59.8	59.8	100	59.7	59.7	59.7	100	59.8	59.8	59.8	100
8....	53.1	52.4	52	96	60.2	59.0	58	94	58.3	57.0	56	92
9....	44.0	43.3	43	95	60.6	56.0	53	76	57.0	55.1	54	88
10....	48.3	48.0	47	98	63.8	59.5	56	78	58.6	56.7	56	89
11....	49.9	49.4	49	97	67.5	61.5	58	71	63.6	61.5	61	90
12....	49.8	49.0	48	94	60.0	54.6	50	70	58.3	57.4	56	94
13....	57.8	57.3	57	97	60.1	55.5	52	75	62.5	61.5	61	95
14....	60.5	60.0	60	97	61.8	61.6	61	99	57.8	57.2	57	97
15....	47.5	47.1	47	96	56.3	53.2	51	82	53.2	51.8	50	91
16....	41.0	40.8	40	99	58.2	53.4	49	71	56.8	55.5	55	92
17....	49.8	48.9	48	93	63.7	59.3	56	77	59.1	57.0	56	89
18....	60.0	59.1	58	94	73.2	70.0	69	85	65.8	65.8	65.8	100
19....	54.2	52.8	51	91	64.2	56.7	51	62	61.3	57.8	55	81
20....	49.8	49.1	49	96	65.8	60.0	56	72	58.8	58.3	58	97
21....	56.2	55.9	55	98	68.8	65.2	63	83	63.2	62.4	61	96
22....	56.5	56.0	56	97	65.6	63.3	62	88	63.8	62.0	61	91
23....	56.4	56.4	56.4	100	68.2	63.0	60	75	57.8	56.6	56	93
24....	50.0	48.9	48	93	62.0	59.0	57	84	59.8	58.3	58	92
25....	48.0	48.0	48	100	79.0	71.4	68	70	72.5	69.0	68	84
26....	60.0	57.0	55	84	66.9	58.0	52	58	62.0	58.2	55	80
27....	51.0	50.6	50	97	70.1	63.1	59	68	58.0	55.9	55	89
28....	54.7	54.7	54.7	100	72.7	69.0	68	83	61.8	59.8	59	92
29....	62.0	61.3	61	95	72.4	68.0	65	79	65.3	64.8	64	97
30....	51.8	50.0	48	88	58.0	50.3	43	58	51.4	49.2	47	86
Means..................				.96				.79				.92
Mean for month..											0.89	

SOIL THERMOMETERS.

1891. September.	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
Day.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1	59.0	61.8	60.8	59.3	62.0	61.5	60.0	60.8	63.0	60.5	61.3	62.0	61.0	61.5	62.0	61.7	61.5	61.3	60.0	60.0	60.0
2	58.5	66.5	63.4	59.0	67.2	64.0	59.5	63.7	62.5	61.5	62.0	63.3	62.0	62.5	62.3	61.2	61.0	61.0	59.8	59.8	59.5
3	57.5	65.9	64.0	58.7	66.7	64.5	59.3	65.4	64.8	61.3	62.5	63.0	61.8	62.5	62.8	60.8	60.7	60.7	59.5	59.4	59.4
4	63.0	67.8	66.8	62.7	67.0	66.3	63.0	64.2	65.3	62.5	63.0	64.8	62.5	62.5	62.8	60.5	60.5	60.5	59.4	59.3	59.3
5	60.3	64.8	64.5	60.5	64.2	64.5	62.6	62.3	63.0	63.3	62.0	62.5	63.0	62.5	62.5	60.7	60.7	60.7	59.1	59.3	59.2
6	61.0	61.5	61.5	61.0	61.5	61.7	62.0	61.7	61.9	62.0	62.0	61.9	62.3	62.2	62.1	60.6	60.6	60.6	59.1	59.2	59.2
7	61.5	61.9	61.7	62.0	62.0	61.5	62.0	61.8	61.5	61.7	61.5	61.3	62.0	61.8	61.7	60.5	60.5	60.5	59.3	59.3	59.3
8	58.8	63.5	62.0	59.0	63.6	62.0	60.5	61.0	62.0	60.7	60.6	61.5	61.5	61.0	61.0	60.5	60.5	60.3	59.3	59.3	59.3
9	55.0	61.3	61.0	55.2	61.3	61.3	58.0	58.5	60.1	59.5	59.0	60.0	60.5	59.8	59.7	60.2	60.2	60.0	59.0	59.1	59.0
10	55.5	62.5	61.7	55.9	62.0	61.9	58.2	59.0	61.0	59.0	58.9	60.2	59.5	59.3	59.6	59.7	59.7	59.6	59.0	59.0	58.9
11	57.0	64.7	63.5	57.0	64.5	64.0	58.7	60.8	62.0	59.4	60.3	61.0	59.7	59.8	60.0	59.5	59.5	59.4	58.8	58.8	58.8
12	58.0	61.5	60.8	58.0	62.0	61.3	59.7	61.8	61.0	60.0	61.2	61.0	60.3	60.8	61.0	59.4	59.5	59.4	58.5	58.7	58.7
13	58.6	62.9	63.0	59.5	61.5	63.0	59.0	60.8	62.5	60.8	61.3	61.5	61.0	61.0	61.0	59.5	59.5	59.5	58.5	58.7	58.5
14	61.5	61.9	63.0	61.5	63.2	62.9	61.5	61.8	62.4	61.2	61.5	61.8	61.0	61.3	61.3	59.5	59.7	59.7	58.5	58.7	58.5
15	58.3	59.5	59.1	57.8	59.3	59.5	59.7	59.2	59.9	60.5	59.7	60.0	61.0	59.4	60.0	59.7	59.7	59.5	58.4	58.5	58.4
16	54.1	59.7	60.5	54.4	59.7	60.7	56.1	58.3	59.8	58.2	57.8	59.0	59.1	58.8	58.7	59.4	59.4	59.2	58.3	58.5	58.3
17	55.7	61.1	61.8	56.0	61.2	62.2	57.9	59.0	61.2	58.5	58.3	59.9	60.0	58.8	59.0	58.9	59.0	58.8	58.3	58.3	58.2
18	59.4	64.8	65.0	59.5	64.3	64.7	59.7	61.2	62.4	59.6	60.0	60.6	59.6	59.7	59.7	58.7	58.9	59.0	58.2	58.2	58.2
19	59.8	61.4	61.8	60.2	61.6	61.9	61.5	60.9	61.7	61.5	60.8	61.0	61.0	60.8	60.7	58.8	59.3	59.2	57.8	58.2	58.1
20	56.0	61.5	60.8	56.0	61.3	61.0	57.7	58.5	60.6	58.7	58.5	59.9	59.8	59.3	59.5	59.1	59.1	59.6	58.1	58.0	58.0
21	58.5	63.7	60.5	58.8	63.5	61.4	59.5	60.8	60.8	59.5	59.6	60.3	59.5	59.7	59.7	58.8	59.0	59.0	58.0	58.0	58.0
22	61.0	64.5	64.0	60.7	64.2	64.0	61.1	62.0	63.0	61.0	61.0	61.8	60.5	60.5	61.0	59.0	59.0	59.0	58.0	58.0	58.0
23	60.5	64.2	62.8	60.5	64.0	62.8	62.5	62.0	62.8	62.0	61.0	61.8	60.7	61.0	61.3	59.1	59.3	59.3	58.0	58.0	58.0
24	57.5	59.5	60.5	67.5	59.3	60.5	59.5	59.2	60.2	60.0	58.5	59.5	60.5	60.0	59.8	59.3	59.3	59.2	58.0	58.0	58.0
25	59.3	65.3	65.8	59.1	64.6	65.8	59.5	61.0	64.3	59.5	60.0	61.5	59.5	59.8	60.5	59.0	59.0	59.0	58.0	58.0	58.0
26	62.1	63.3	63.3	62.3	63.8	63.7	62.5	62.3	63.0	62.0	61.8	62.1	61.4	61.4	61.4	59.0	59.3	59.3	58.0	58.0	58.0
27	57.2	62.3	61.5	57.0	62.5	61.8	59.2	60.0	61.5	60.0	60.0	60.5	60.5	59.3	60.2	59.5	59.5	59.3	58.0	58.0	58.0
28	59.5	63.5	65.5	59.8	63.5	63.7	60.0	60.0	63.0	60.2	59.1	60.3	60.2	59.5	60.3	59.3	59.3	59.2	58.0	58.0	58.0
29	61.5	65.0	64.3	61.5	65.0	64.5	61.5	62.1	63.4	61.0	61.0	62.1	60.5	60.9	61.3	59.0	59.0	59.2	58.0	58.0	58.0
30	59.0	58.5	57.5	59.3	59.0	57.8	61.1	59.5	59.5	61.5	60.2	60.0	61.3	60.7	60.0	59.1	59.3	59.2	58.0	58.0	58.0
Means	58.82	62.88	62.41	59.00	62.85	62.55	60.43	60.99	62.00	60.51	60.48	61.21	60.77	60.60	60.73	59.67	59.70	59.65	58.53	58.61	58.36

SEPTEMBER, 1891.

	Maximum and Minimum Thermometers and Record of Sunshine.			Terrestrial Radiation and Sun Thermometer.		Precipitation.			Anemometer observed at 1 P.M.		
Day	Maximum.	Minimum.	Hours of Sunshine.	Terrestrial Radiation.	Sun Thermometer.	Time of beginning.	Time of ending.	Amount of rain in inches.	Reading.	Number of miles in last twenty-four hours.	Average rate per hour.
	°	°		°	°						
1	61.7	50.3	0	43.6	104.6	1.45 P.M.	Night	.21	847.3	137.1	5.71
2	68.9	50.7	13	41.5	133.8				951.5	104.2	4.34
3	77.0	46.5	13	38.7	135.1				985.8	34.3	1.43
4	71.9	48.8	6	41.3	132.8				342.5	346.7	14.45
5	66.3	48.1	6	42.5	129.2				553.0	210.5	8.77
6	62.5	53.4	0½	48.9	79.1	early a.m			602.4	49.4	2.58
7	62.8	57.8	0	51.2	71.6		8.30 P.M.	2.25	662.4	60.0	2.50
8	67.3	49.9	8	41.8	130.0				881.1	218.7	9.11
9	68.0	39.3	8½	28.8	127.0				42.5	151.4	6.31
10	72.0	43.8	12½	32.3	135.1				173.2	130.7	5.45
11	76.1	43.9	12½	37.3	135.0				277.5	104.3	4.35
12	65.7	45.0	12½	38.8	134.7				335.5	58.0	2.42
13	60.8	43.8	0	39.2	82.3	9.45 P.M.	Night	.10	629.4	293.9	12.25
14	72.3	57.8	6	44.6	119.6	11.15 A.M.	1 P.M.	.60	773.2	143.8	5.99
15	62.5	45.9	9	36.5	119.0				957.8	184.6	7.69
16	68.0	38.2	12	31.4	125.1				36.6	68.8	2.87
17	71.9	44.3	12	38.5	122.5				101.3	64.7	2.70
						early a.m	6 A.M.	.05	301.5	200.2	8.34
18	75.4	53.2	3	50.5	118.2	5 P.M.	7 P.M.	.17	625.2	323.7	13.49
19	70.7	54.5	12	50.4	124.9				708.3	83.1	3.46
20	71.0	37.8	12	27.5	123.8				792.6	84.3	3.51
21	74.3	54.0	5	48.0	137.2	2 P.M.	7 P.M.	.10	841.3	48.7	2.29
22	68.8	55.6	0	53.8	110.3				971.5	130.2	5.43
23	73.0	53.5	9	50.5	133.7				145.5	164.0	6.83
24	64.0	44.2	8	36.3	115.3				353.6	208.1	8.67
25	86.0	56.9	12	52.2	133.9				616.0	262.4	10.93
26	73.3	59.9	11	53.9	125.6				723.7	107.7	4.49
27	73.0	40.1	12	34.5	129.8				874.3	150.6	6.28
28	76.2	49.0	9½	39.7	130.0				154.6	270.3	11.26
29	73.9	60.0	8	52.0	130.3	Night	Night	.02	622.4	467.8	19.49
30	60.0	50.7	11½	40.5	111.0						
		Total,	234½				Total,	3.50	Total,	4862.2	
M'ns	69.84	49.23	7.8	42.22	121.65					162.07	6.75

Report of Botanist and Entomologist.

PROF. F. L. HARVEY.

The following subjects have claimed attention during the past season:

BOTANY.

1. Germination experiments on the vitality of seeds, continued.
2. *Datura Stramonium*, L. Jamestown Weed. Described.
3. *Raphanus raphanistrum*, L. White Radish, or Jointed Charlock.
4. *Rumex crispus*, L. Yellow Dock.
5. *Rumex obtusifolius*, L. Bitter Dock.
6. *Bromus secalinus*, L. Chess or Cheat, considered and illustrated.
7. Several species of Mosses studied in reference to their value as foods for domestic animals.
8. Continuation of an examination of Potato Rot.
9. Continuation of an examination of Black Knot.
10. Correspondence regarding weeds, seeds and plants.
11. Examination of Seeds for impurities.
12. Collecting of seeds, weeds, forage and other plants for the herbarium, continued.

ENTOMOLOGY.

13. *Ixodes ricinus*, L. Tick.
14. *Smerinthus geminatus*, Say. Sphinx moth.
15. *Treptogon modesta*, Harris. Sphinx moth.
16. *Sphinx gordius*, Cramer. Sphinx moth.
17. *Agrostis saucia*, Hubner. Climbing cut-worm.
18. *Agrostis Ypsilon*, (Rott.) Greasy cut-worm.
19. *Hadena devastatrix*, (Brace.) Glassy cut-worm.
20. *Apatela lepusculini*, Gue. The Cotton Dagger.
21. *Aphonus tridentata*, Say. Three-toothed Aphonus.
22. *Dytiscus verticalis*, Say.
23. Three species of Rove Beetles.
24. *Elaphidion parallelum*, Newm.
25. *Ptinus brunneus*, Duft.
26. *Aphis mali*, Fabr. Apple Aphis.
27. *Cotalpa lanigera*, (Linn.) Gold-smith Beetle.
28. *Tetranychus 4-maculata*, n. sp. Four spotted mite,

PLANTS RECEIVED FOR EXAMINATION—1891.

WEEDS.

No.	Common Name.	Scientific Name.	From whom Received.	Remarks.
1	Jamestown weed.	Datura Stramonium, L.	Several parties.	Weed in gardens.
2	White Radish, or Jointed Charlock.	Raphanus raphanistrum, L.	A. J. Abbott, West Paris, Me.	Pods abundant in Western oats shipped to Maine.
3	Yellow Dock.	Rumex crispus, L.	Various parties.	Weed in waste ground, fields and gardens.
4	Bitter Dock.	Rumex obtusifolius, L.	Various parties.	Weed in waste ground, fields and gardens.
5	Chess, or Cheat.	Bromus secalinus, L.	Mr. F. V. Barker, Athens, Me.	Weed on the farm.
		MOSSES.		
6	Bog Moss.	Sphagnum cymbifolium, Ehrb.	Henry A Sprague, Charlotte, Maine.	Sent for determination and for an examination as to nutritive value for feeding domestic animals.
7	Bear's Bed, or Robin's Rye.	Polytrichum Juniperinum, Hedw.		
8	Splendid Hypnum.	Hypnum splendens, Hedw. H. proliferum, L.		
9	Schreber's Hypnum.	Hypnum Schreberi, Willd.		
10	Reindeer moss—a lichen.	Cladonia rangiferina.	Collected at Orono.	Analyzed for comparison.

LIST OF INSECTS REPORTED AND EXAMINED—1891.

No.	Common Name.	Scientific Name.	By whom Reported.	Remarks.
1	Tick.	Ixodes ricinus, L.	Thos. Lord, Skowhegan, Me.	Infesting domestic cat.
2	Sphinx Moth.	Smerinthus geminatus, Say.	W. N. Bond, Orono, Me.	About apple trees.
3	Sphinx Moth.	Triptogon modesta, Harris.	Q. E. Young, Costigan, Me.	Habit not reported. Food plants, poplar and cottonwood.
4	Sphinx Moth.	Sphinx gordius, Cramer.	L. E. Fogg, S. Thomaston, Me.	Said to be feeding on the foliage of plum trees. Not abundant.
5	Climbing Cut-worm.	Agrostis saucia, (Hubner).	W. K. Burgess, Monroe, Me.	The eggs of this in abundance were found attached to resined cloth used for grafting.
6	Greasy Cut-worm.	Agrostis Ypsilon, (Rott.)	N. H. Sleeper, Lewiston, Me.	Working in corn, potatoes and beans.
7	Glassy Cut-worm.	Hadena-devastatrix, (Brace.)	John M. S. Hunter, Farmington, Me. N. H. Sleeper, Lewiston.	Doing great damage in lawn of public building, and to corn.
8	The Cottonwood Dagger.	Apatela lepusculini, Gue.	W. H. Phinney, Standish, Me.	Upon plantain in door yard.
9	Three-toothed Aphonus.	Aphonus tridentatus, Say.	N. H. Sleeper, Lewiston, Me. C. V. Manley, Auburn, Me.	Accused of cutting off corn below ground.
10		Dytiscus verticalis, Say.	F. H. Skinner, Corinth, Me.	Found in cellar among potatoes.
11	Rove Beetles.	Three species.	W. K. Burgess, Monroe, Me.	Abundant fastened to resined cloth used for grafting.
12	The Parallel Elaphidion.	Elaphidion parallelum, Newm.	W. K. Burgess, Monroe, Me.	Boring in plum twigs.
13		Ptinus brunneus, Duft.	Mrs. E. Gardner, Calais, Me.	Live larva and beetles in red pepper.
14	Gold-smith Beetle.	Cotalpa lanigera, Linn.	Allen Reed, Frye, Me.	Habitat not stated.
15	Apple Aphis.	Aphis mali, Fabr.	Ch. H. Pope, Manchester, Me.	Feeding on raspberry bushes.

PLANTS RECEIVED FOR EXAMINATION—1891.

WEEDS.

No.	Common Name.	Scientific Name.	From whom Received.	Remarks.
1	Jamestown weed.	Datura Stramonium, L.	Several parties.	Weed in gardens.
2	White Radish, or Jointed Charlock.	Raphanus raphanistrum, L.	A. J. Abbott, West Paris, Me.	Pods abundant in Western oats shipped to Maine.
3	Yellow Dock.	Rumex crispus, L.	Various parties.	Weed in waste ground, fields and gardens.
4	Bitter Dock.	Rumex obtusifolius, L.	Various parties.	Weed in waste ground, fields and gardens.
5	Chess, or Cheat.	Bromus secalinus, L.	Mr. F. V. Barker, Athens, Me.	Weed on the farm.
		MOSSES.		
6	Bog Moss.	Sphagnum cymbifolium, Ehrb.	Henry A Sprague, Charlotte, Maine.	Sent for determination and for an examination as to nutritive value for feeding domestic animals.
7	Bear's Bed, or Robin's Rye.	Polytrichum Juniperinum, Hedw.		
8	Splendid Hypnum.	Hypnum splendens, Hedw. H. proliferum, L.		
9	Schreber's Hypnum.	Hypnum Schreberi, Willd.		
10	Reindeer moss—a lichen.	Cladonia rangiferina.	Collected at Orono.	Analyzed for comparison.

LIST OF INSECTS REPORTED AND EXAMINED—1891.

No.	Common Name.	Scientific Name.	By whom Reported.	Remarks.
1	Tick.	Ixodes ricinus, L.	Thos. Lord, Skowhegan, Me.	Infesting domestic cat.
2	Sphinx Moth.	Smerinthus geminatus, Say.	W. N. Bond, Orono, Me.	About apple trees.
3	Sphinx Moth.	Triptogon modesta, Harris.	Q. E. Young, Costigan, Me.	Habit not reported. Food plants, poplar and cottonwood.
4	Sphinx Moth.	Sphinx gordius, Cramer.	L. E. Fogg, S. Thomaston, Me.	Said to be feeding on the foliage of plum trees. Not abundant.
5	Climbing Cut-worm.	Agrostis saucia, (Hubner).	W. K. Burgess, Monroe, Me.	The eggs of this in abundance were found attached to resined cloth used for grafting.
6	Greasy Cut-worm.	Agrostis Ypsilon, (Rott.)	N. H. Sleeper, Lewiston, Me.	Working in corn, potatoes and beans.
7	Glassy Cut-worm.	Hadena devastatrix, (Brace.)	John M. S. Hunter, Farmington, Me. N. H. Sleeper, Lewiston.	Doing great damage in lawn of public building, and to corn.
8	The Cottonwood Dagger.	Apatela lepusculini, Gue.	W. H. Phinney, Standish, Me.	Upon plantain in door yard.
9	Three-toothed Aphonus.	Aphonus tridentatus, Say.	N. H. Sleeper, Lewiston, Me. C. V. Manley, Auburn, Me.	Accused of cutting off corn below ground.
10		Dytiscus verticalis, Say.	F. H. Skinner, Corinth, Me.	Found in cellar among potatoes.
11	Rove Beetles.	Three species.	W. K. Burgess, Monroe, Me.	Abundant fastened to resined cloth used for grafting.
12	The Parallel Elaphidion.	Elaphidion parallelum, Newm.	W. K. Burgess, Monroe, Me.	Boring in plum twigs.
13		Ptinus brunneus, Duft.	Mrs. E. Gardner, Calais, Me.	Live larva and beetles in red pepper.
14	Gold-smith Beetle.	Cotalpa lanigera, Linn.	Allen Reed, Frye, Me.	Habitat not stated.
15	Apple Aphis.	Aphis mali, Fabr.	Ch. H. Pope, Manchester, Me.	Feeding on raspberry bushes.

REMARKS.

Those of the above named plants and insects that have been sufficiently studied, or are of enough importance receive consideration below. The plates and cuts to illustrate this Report were obtained from the following sources: From the Dept. of Agric., Washington, D. C., the plate of *Bromus secalinus;* cuts 1, 2, 3, 4, 6, 7 and 10 from J. B. Lippincott & Co., and are after cuts in Saunder's Insects Injurious to Fruits; cuts 5, 8, 11, 12 and 13 were kindly loaned by Prof. S. A. Fobes and are after cuts in the Ill. Repts.; cut 9 is from a drawing made by the writer.

During the past season the writer assumed alone the botanical and entomological work of the Station, but Mr. F. P. Briggs, Assistant in the Natural History Department of the College, has continued in an efficient manner the germination experiments and collecting for the herbarium.

The appointment of a Station Horticulturist has transferred the work of the Botanist and Entomologist largely to the study of life histories of plants and insects found doing injury in the State. The Horticulturist has assumed the work of testing fungicides and insecticides. Insects and plants for identification and questions regarding their habits will be considered by the writer, but questions regarding spraying and spraying apparatus should more properly be referred to Prof. Munson. We take this occasion to say that any one desiring information regarding insects or plants is at liberty to send specimens or ask questions. We are glad to notice an increasing demand for such information. Directions for sending specimens will be found in Experiment Station Report, 1888, p. 194.

The past season has not been characterized by the wide spread occurrence of any one species of fungus or injurious insect. The ravages of the Forest-tent Caterpillar, so serious and threatening in 1890, amounted to almost nothing the past season, as we predicted would be the case in our last Report. The past season was quite wet and many complaints were received of injuries done by various species of cut worms. The Codling Moths and Apple Maggot were as abundant as usual in some sections of the State. There seems to be an awakening to the importance of spraying for Apple Scab and the Codling Moth, as more inquiries have been received than usual regarding fungicides, insecticides and apparatus. Complaints from two sources were received of injuries done to corn by *Aphonus tridentatus*, Say. This insect has never before been accused of cutting corn in the hill after the manner of a cut worm. Our attention has been directed the past season to a species of mite which is common on house plants in Orono, and also in the forcing house at the College. This is the same species that has done so much damage at Cornell University and elsewhere in green houses. It seems to be wide spread and a serious pest. It is very closely related to the red spider, being a species of *Tetranychus*. There were some newspaper reports of the appearance of the Gypsey Moth in the western part of the State, but we are not able to find any authentic evidence that it is found in the State. The Fall Canker-worm has been gradually increasing in the Penobscot valley for the past four years. Last season it did considerable damage to the foliage of fruit and shade trees in this vicinity, and numerous eggs were laid last fall. It may be expected to give some trouble the coming season. Spraying with Paris green while the worms are young, is the remedy. The Apple Scab seems to be the most injurious fungus the orchardists have to contend with, but the use of copper compounds will no doubt prove an efficient remedy.

It may be well to state that the new Tachinid referred to in the Expt. Station Report, 1890, p. 139, as parasitic upon the Forest-tent Caterpillar and named *Phorocera promiscua*, Townsend, has since been referred by the same author to the genus *Meigenia*, and should now be called *Meigenia promiscua*, Townsend. See Psyche, Nov., 1891, p. 177.

BOTANY.

JAMESTOWN WEED—THORN APPLE.

Datura Stramonium, L.

Specimens of the above species have been handed to us for determination several times during the past five years. We have observed the plant several times as a weed in gardens about Orono, and it may be common throughout the State. Whether introduced in garden or grass seed we do not know. Though it appears from year to year in this region, yet being a tropical plant it would probably not spread. It is a native of *Asia* introduced in America. In the South it grows several feet high and is a rank weed found about barns and out houses where the soil is rich, or in fields and along road sides. The seeds are officinal and constitute the *Stramonium* of the druggist. In the South the seeds are pulverized and mixed with lard to form an ointment much used for healing sores. The plant may be known by the long, funnel-shaped, white corolla, with a large five to ten toothed plaited border; the large, globular, prickly seed pod, four celled at the bottom; the large, flat seeds, and the ovate, ill-scented foliage. The flowers are borne on short peduncles in the forks of the branching stems. The plant is a member of the order *Solonaceæ* to which the potato, tomato and tobacco belong. It is closely related to *Datura* (Brugmansia) *arborea*, a shrubby plant bearing white *Datura*-like blossoms fully six inches long and grown as a house plant in Maine and called *Wedding Bell*. Those who have access to the U. S. Agr'l Rept. for 1889, will find this plant figured on Pl. VII in the Report of the Botanist.

WHITE RADISH OR JOINTED CHARLOCK.

Raphanus raphanistrum, L.

The following letter from Mr. Abbott, together with the response, being of general interest, are recorded.

WEST PARIS, ME., Jan. 2, 1890.

W. H. JORDAN.

Dear Sir:—I send you some oats with which are some seeds that are new to me. Can you tell me what they are? They are Western oats such as are brought here by the car load for feed.

Very Respectfully,

A. J. ABBOTT.

RESPONSE.

ORONO, ME., Jan. 9, '91.

MR. A. J. ABBOTT,

WEST PARIS, ME.

Dear Sir:—Your letter and package were handed me by Prof. Jordan for consideration. The foreign matter in the oats sent consists of the pods and included seeds of *Raphanus Raphanistrum, L.* The Wild Radish or Jointed Charlock. The plant yielding these pods is a troublesome weed in Eastern New England and farther west. It is a near relative of the garden Radish, *Raphinus sativus, L*, and was introduced from Europe. This plant belongs to the Order *Cruciferæ* or *Mustard Family*. The pods are necklace-formed and break into joints by constrictions between the seeds, as shown by the specimens sent. By examining the joints of the pods, you will find the *brownish spherical* seeds. What the physiological effects of eating so much radish seed would be upon animals I cannot say, but as the seeds of some *cruciferous plants* yield an irritating pungent oil, the effect would probably be like that of mustard seed, laxative and stimulating to the digestive organs. This effect would not be desirable in healthy animals. The radish seed, though an adulteration, would have some nutritive value. Clean oats would be preferable and this adulteration ought to make them of less market value. Such oats should not be used as seed, as this bad weed would be introduced whereever they were sown. It would not be possible to feed such oats on the farm without introducing the weed. We would advise farmers not to buy them. The weed is already in the State, being rather common about Orono. Care should be taken not to further extend it. It may be said in its favor, that it is an annual; and could be eradicated in one season, by careful tillage. We would like to know whether the oats received from the West are often thus adulterated or whether this is the first time you have seen it. I wish you would send me a quart of the seed adulterated just as taken from the car. I want to determine the per cent. of foreign matter and keep the sample for the museum.

Yours very truly,
F. L. HARVEY,
Botanist for the Station.

YELLOW DOCK AND BITTER DOCK.

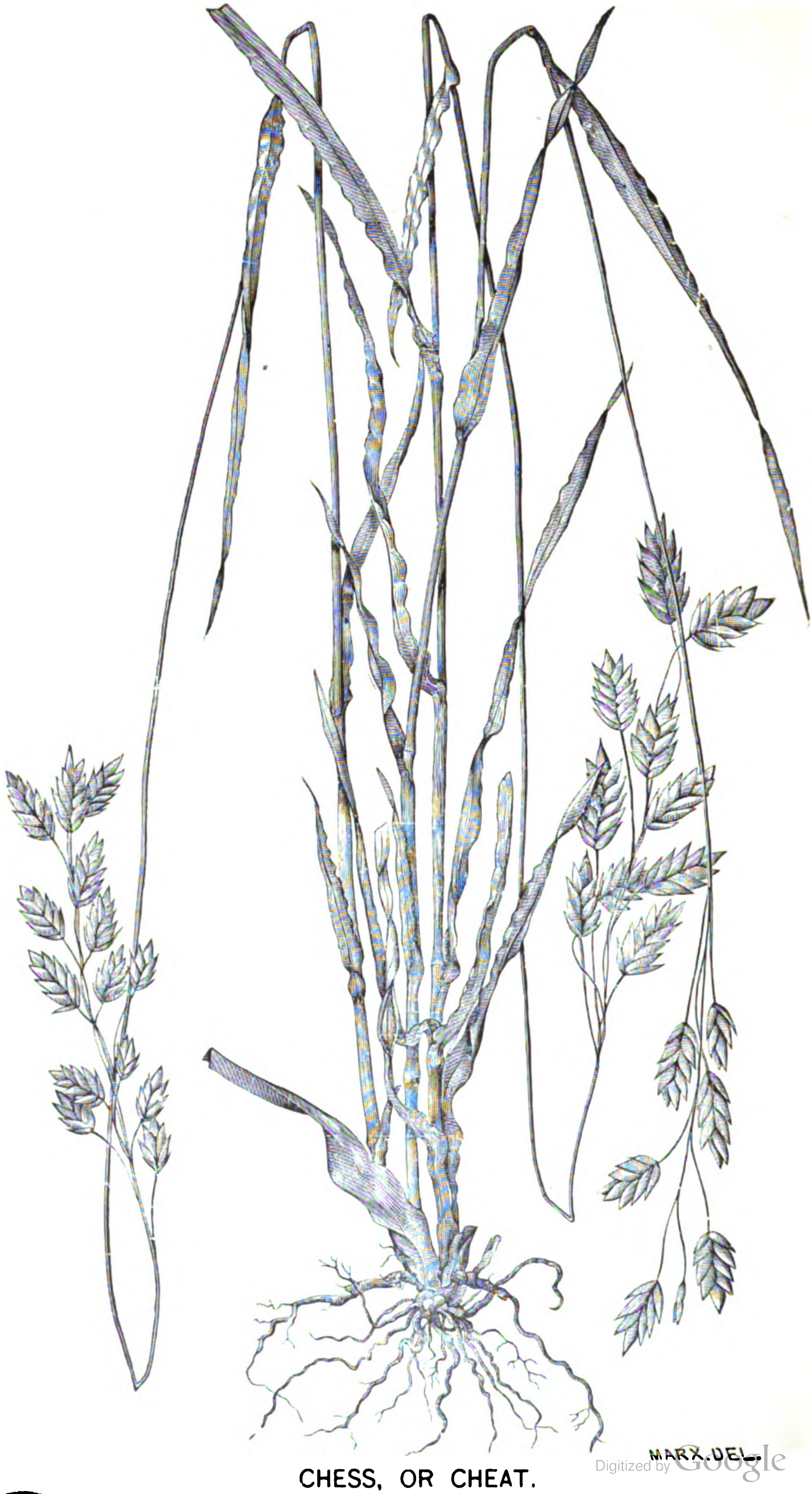
Rumex crispus, L, *and Rumex obtusifolius*, L.

The above species sent for determination are common weeds in fields, gardens and waste ground. They are naturalized from Europe. The Curled Dock is smooth, has lanceolate acute leaves with the margins strongly wavy curled. The lowest leaves truncate or scarcely heart-shaped at the base. The flowers in crowded whorls on a long wand-like raceme. The valves (three inner sepals) round, heart shaped with an obscure toothed or entire border and nearly all grain bearing.

The Bitter Dock has a rough stem, the lowest leaves ovate heart-shaped and obtuse. Flowers in loose, distinct whorls. The valves strongly veined, ovate shield-shaped with sharp, awl-shaped teeth at the base. Only one usually grain bearing.

These plants belong to the order *Polygonaceæ* or Buckwheat Family, and are related to the smart weeds and the cultivated buckwheat. They are figured in the U. S. Agr'l Rept., 1889, Pl. VIII and IX in the Rept. of the Botanist.

Those interested in the species of *Rumex* (docks) occurring in the United States, will find all the species considered (about twenty) and finely illustrated in the Third Annual Report of the Mo. Bot. Garden, in an article from the pen of Prof. Wm. Trelease, Director, St. Louis, Mo.



CHESS, OR CHEAT.

CHESS, OR CHEAT.

Bromus secalinus, L.

A letter containing specimens of the above named grass was received from Mr. F. V. Barker, Athens, Me., who stated that the plant grew on his farm and he wished to know whether it was of any value. The following response may be interesting in connection with the cut we give of this species on the opposite page.

ORONO, ME., Dec. 10, '91.

MR. F. V. BARKER,
ATHENS, ME.

Dear Sir:—The specimen of grass you forwarded to Prof. Balentine has been handed to me for examination. It is Chess or Cheat, known to botanists by the name *Bromus secalinus*, L. Some farmers still hold to the old tradition that Chess is a degenerate wheat, but most now know it is a distinct species, which sometimes overruns grain fields. The seed is sometimes sown with the grain, but more often gets in from neglected fence corners or hedge rows. It is a very hardy, coarse plant, that seeds profusely and would soon overrun a field if not checked. It is an annual, hence careful cutting for one season would eradicate it. It is of no value to the farmers of Maine, though it has been suggested as a winter grass for the South, where some of its near relatives are esteemed. It is rather to be regarded as a weed and should be destroyed. It is not a native grass, but was introduced from Europe. It may be recognized by the aid of the accompanying cut and the following description: Flowering glume oblong, convex on the back; flowers lapping over one another before expanding; lower empty glume distinctly 3—5 nerved, the upper 5—9 nerved, annual; panicle spreading, even in fruit, the drooping peduncles little branched; spikelets oblong-ovate, turgid, smooth, of 8—10 flowers; glume rather longer than the palet, short awned or awnless; sheaths nearly glabrous. Growing in fields or waste places as though introduced.

Respectfully,
F. L. HARVEY,
Botanist for the Station.

EXAMINATION OF MOSSES.

L. H. Merrill and F. L. Harvey.

The following letter was received at the Experiment Station last fall.

CHARLOTTE, ME., Nov. 30, 1891.

MESSRS. OF THE EXPERIMENT STATION.

Dear Sirs:—As the U. S. Agr'l. Repts. and Bentley's Botany, state that some mosses are rich in nutriment, and as our school text books skip these cryptogams, I send you three specimens for examination, which I hope you will report upon to me as soon as convenient.

No. 1 is found in large quantities covering mossy low bogs with a soft cushion from six to eighteen inches thick. If *scalded* and mixed with a very little *corn meal* it is eaten with apparent relish by swine.

No. 2 grows on a little higher ground around the edge of bogs.

No. 3 grows in sandy places on high ground. Have any of them any nutritive value as foods for animals?

Yours truly,

HENRY A. SPRAGUE.

The specimens refered to above were submitted to the Botanist of the station for botanical determination and to the Chemist of the station for analysis, with the following results.

BOTANIST'S REPORT.

No. 1. Sphagnum cymbifolium, Ehrb. Bog Moss.

No. 2. Polytrichum Juniperinun, Willd. Bear's Bed, or Robin's Rye.

No. 3. Hypnum splendens, Hedw.—H. proliferum, L.

No. 4. Hypnum Schreberi, Willd.

No. 5. Cladonia rangiferina. Reindeer Moss—a *lichen*.

REMARKS.

Mr. Sprague's No. 3 was a mixture of two species, Nos. 3 and 4 above, which are reported in the analysis. No. 5, the Reindeer Moss, being a well known food of species of *Cervidæ*, was submitted to chemical examination for the sake of comparison.

The accounts given in works on botany, or elsewhere of *mosses* being used as food for man and the lower animals, generally if if not always refer to *lichens*, which should not be confounded with the *musci* or true mosses. We find no authentic record of *true mosses* being eaten voluntarily or having been fed to domestic animals. It is a fact of common observation that the domestic animals reject them. This may be due to their being unpalatable or possibly in some cases to deleterious properties. As animals will not eat them unprepared, they would have to be mixed, if fed, with something to make them palatable, as was done by Mr. Sprague. Whether they possess deleterious properties would have have to be determined by feeding experiments for each species. As the mosses have apparently never been examined chemically to determine their nutritive value, the results of the Station Chemist given below will be interesting. They indicate that the species examined contain much more nitrogen than the *lichen* (reindeer moss,) which is freely eaten by species of deer and that they compare favorably with timothy hay in amount of nitrogen, though it is less easily digested. A series of experiments to determine palatability, deleterious properties and digestibility would be interesting. A more exhaustive analysis might detect compounds that would materially affect the food value. The following is the

REPORT OF THE CHEMIST—MR. L. H. MERRILL.

Since the mosses are not likely to become very important food plants, it was not thought advisable to make a complete analysis of the specimens submitted, but to confine the work to a brief examination of the nitrogenous compounds which they contain. While we do not know the exact nature of these compounds as they exist in the species examined, yet it may be assumed that their value may be determined with some degree of accuracy by applying the same methods used in the study of fodders.

It is evident that the value of the mosses as food must depend upon their digestibility. They were accordingly submitted for twenty-four hours to the action of pepsin solution, prepared in the ordinary manner. The nitrogen was determined in the undigested residues, and the per cent. of the whole amount of the nitrogen digested calculated from these figures.

As a matter of interest a common lichen (Cladonia rangiferina) was added to the list. Two well-known fodders, Timothy Hay and Alsike Clover, have also been inserted in the table for more ready comparison.

Station number.	Names.	Mixture.	Total nitrogen.	Not digested by pepsin, %	% of total not digested.
CLIII	Sphagnum cymbifolium, Ehrb.	8.30	.89	.60	33
CLIV	Polytrichum juniperinum, Willd.	5.25	.90	.74	18
CLV	Hypnum splendens, Hedw.	10.09	1.21	.79	36
CLVI	H. schreberi, Willd.	9.80	.94	.73	22
CLVII	Cladonia rangiferina.	6.59	.42	.23	45
XLIV	Timothy Hay	....	1.20	.34	72
XLI	Alsike Clover	....	2.03	.55	73

It will be seen from these figures that one of the mosses contains as much nitrogen as the Timothy Hay; the others about three-fourths as much. The digestibility, however, in all of them is very low, in none of them reaching more than one-half that shown by Timothy. Nevertheless, if these figures be accepted as representing the actual food-value of the mosses and they prove palatable—which is doubtful—the facts obtained would seem to justify farther study.

EXAMINATION OF SEED FOR IMPURITIES.

The Station is prepared, so far as its facilities permit, to examine seeds for the presence of noxious weeds, and report upon them. Below is given the results of an examination to call attention to the nature of the work. Seeds of weeds present that can not be identified at sight, are grown and positively determined from the plant. Those intending to plant large areas of clover or grass could be assured of the absence or presence of noxious weeds and sometimes avoid the introduction of pests hard to eradicate when once established.

REPORT.

Weight of seed examined, one half ounce.
Name of seed, Red Clover, Trifolium pratense, L.

Total number of weed seeds,	121
Harmless—Herds Grass, Phleum pratense,	30
Harmful—Fox tail, Setaria glauca,	59
" Smart weed, Polygonum acre,	12
" Black Bindweed, Polygonum convolvulus, L,	
" Polygonum ?	
Rib Grass, Plantago lanceolata, L.	5
Unknown Weeds, two kinds,	15
Total,	121

Received from Mr. G. S. Flood, Waterville, Me., and purchased from F. J. Savage, Ft. Fairfield, Me.

REMARKS.

It is impossible to gêt seed entirely free from foreign seeds. It is important, however, whether the few found are *harmless* like herds grass seed in clover, or whether they are the seeds of bad weeds. The above seed can not be regarded dirty, as the weight of foreign matter is very small, but it contains the seed of the *foxtail* and *English plantain*, one would not care to introduce in a meadow. For my own planting I would reject such a seed as the above.

ENTOMOLOGY.

TICKS.

Ixodes ricinus, L.

(Ord. Acarini: Fam. Ixodidæ).

We received specimens of a species of Tick from Mr. Thos. Lord of Skowhegan, found on the domestic cat. The American species of Ticks have not been studied much and the writings on the subject are meagre. Not being able to find a description of the species, some of the specimens were referred to the Dept. of Agric., Division of Entomology. They were examined by Dr. Marx, and Prof. Riley writes us that the form is *Ixodes ricinus*, L. The species sent us is very common in Maine and is the one which so badly infests our wild hare, or rabbit. We have seen rabbits during the month of July with the head almost covered with these ticks and in such a condition it must have been a misery to live.

Dr. Marx of the Dept. of Agric., we understand, is studying this group, and we may hope for a monograph of our American species.

SPHINX OR HAWK MOTHS.

(Order Lepidoptera: Fam. Sphingidæ.

During the past season three species of sphinges have been received for examination, viz: *Smerinthus geminatus*, Say., *Triptogon modesta*, Harris, and *Sphinx gordius*, Cram.

As these moths are apt to attract attention on account of their size, a few words regarding them may be interesting.

They are called Sphinx moths, or Sphinges, because the *larvæ* have the curious habit of raising the anterior portion of the body and remaining motionless for a long time in that position, thus bearing a fancied resemblance to the fabled *Sphinx*.

HABITS.

The eggs are laid singly on the food plant, hatch in one or two weeks; the young larvæ are usually pale green or yellowish green and clothed with short, erect hairs. They molt or shed the skin about four times before they are fully grown. They have on the twelfth segment a spine that curves backward and is called the *caudal horn.* (This horn disappears after the first molt in a few species.) The mature larva is cylindrical and smooth or granulate. When done feeding they descend and usually enter the ground to transform, though a few make imperfect cocoons on the surface made of leaves drawn together with silk.

The moths are medium sized to large, the bodies short, fore wings comparatively long and narrow, hind wings much smaller, head large, clothed with hair-like scales, either tufted or appressed; eyes, large, hemispherical, naked. The proboscis usually long and slender and when not in use, coiled like a watch spring between the palpi. The wings usually move rapidly in flight. They are sometimes taken for humming birds. This is quite a large family, there being, according to Prof. J. B. Smith, over eighty species in temperate North America. According to Prof. Fernald there are nearly fifty species in New England, the most of which occur in Maine. Quite a number of the species feed upon the foliage of fruit trees, forest trees and shrubbery of economic importance. Of those mentioned above, *Smerinthus geminatus*, Say., is a general feeder and has been found upon the apple, plum, elm, ash and willow.

Triptogon modesta, Harris, feeds upon the poplar and cotton wood.

Sphinx gordius, Cramer, (Fernald Sphinges of New England, p. 44, Fig. 1, Pl. 1), has been called the Apple Sphinx on account of its common occurrence in orchards, but it feeds upon the ash, also upon the Sweet Gale (Myrica Gale, L. and the Wax Myrtle, Myrica Cerifera, L.) Those who are interested in the above species, or in the Sphinges generally will find the Sphinges of New England considered in detail in Fernald's Sphingidæ of New England, published in the Agr'l Rep't of Maine, 1886, or the Sphinges of America, north of Mexico, in Prof. J. B. Smith's Monograph, published by the American Entomological Society of Philadelphia, Pa.

CUT-WORMS.

The following letter regarding cut-worms was received at the Station. We place it and the answer on record as containing information perhaps important to others.

FARMINGTON, ME., 6, 5, 1891.

DEAR SIR:

I send you by this mail specimens of a worm which is destroying a lawn in this place, in front of and around our county building. The soil is sandy and it has been top dressed for several seasons to get the lawn; and now the turf is about two inches thick. Rear of the building is a cemetery, been there for over a century.

Will you kindly look into this matter; tell us what the worm is, how to prevent further ravages by it, and what to do to kill out the thousands of worms now eating away at the grass roots.

I shall make an item about this lawn, also say I have sent specimens to the State College; and I hope you will write an article upon them to print in my paper. Nobody here, thus far has ever seen these worms here before.

Yours very truly,

JOHN M. S. HUNTER.

ANSWER TO MR. HUNTER'S LETTER.

ORONO, ME., July 24, '91.

Editor of Farmington Chronicle:

The specimens which you sent me some time ago for examination prove to be the Glassy Cut-worm known to entomologists as *Hadena devastatrix*, (Brace). There are a great many species of the so-called *Cut-worms*; some of them climb trees and eat the foliage, while others work about the roots or base of plants. They all do more or less damage and work at night. As a class they are hard to manage. When they are not numerous and affect gardens, digging them out of the hills where their depredations are noticed, or putting bunches of hay or small boards on the ground for them to hide under, and then examining and killing them, have proved good remedies.

When they affect field crops, meadows or lawns the treatment would have to be different and on a more extensive scale. If the lawn has been so far affected that the grass is dead and re-seeding will be necessary, the ground should be plowed next Spring and before the seed is sown a load of fresh cut grass thoroughly sprinkled with Paris green in water, 1 lb. to 150 gallons of water, should be spread upon the ground and left a few days. The worms will crowd to the surface for food, eat of the poisoned grass and die.

This same treatment has been successfully tried for cut-worms in corn fields or other crops planted in rows, the poisoned grass or c'over being scattered in small bunches between the rows. If the lawn has not been destroyed so that re-seeding is necessary, and it is desired to treat it without disturbing the sod, then we would advise the use of Kerosene Emulsion. This has been successfully used for grubs in lawns at the Department of Agriculture, Washington, D. C.

You will find an account of the Experiments in Insect Life, Vol. 1, No. 2, page 48. (This journal is published by the Department of Agriculture and you can no doubt get a copy by addressing the Secretary of Agriculture.) You will find a formula for the preparation of Kerosene Emulsion in Dep't of Agriculture Report, 1884, page 331, and also some other information on the subject that will be instructive. Other articles on the treatment of cut-worms will be found in Insect Life, Vol. 3, No. 5, page 247; U. S. Agricultural Report 1885, page 270; Prof. Fletcher's Report, Central Expt. Farms, Ottawa, Canada, 1889; Canadian Entomologist 1889, Sept. or Oct., also in the writings of Prof. Cook and other entomologists to the Experiment Stations.

As the above cut-worm goes into the chrysalid state in July, its depredations are probably over for this season and it is more than probable, it apparently being confined to the lawn in question, that it will not give so much trouble next season. The chrysalids hatch into moths in the latter part of August or September and they will scatter to lay their eggs. Cut-worms are apt to be badly preyed upon by parasites and thus destroyed. Should they begin work again next Spring I would advise the grass trap or Kerosene Emulsion treatment. Should you need any more detailed information than I have given, write again.

Yours truly,

F. L. HARVEY,

Entomologist for the Station.

REMARKS.

The above species, *Hadena devastatrix* (Brace), together with the Greasy Cut-worm, *Agrostis Ypsilon* (Rott.), were received from Mr. Sleeper, Auburn, Me., see letter pp. 200, 201, also reared by the writer from worms doing damage to corn and other crops about Orono. A species of Climbing Cut worm, the Variegated Cut-worm, *Agrostis saucia* (Hubner), was sent by Mr. W. K. Burgess, Monroe, Me.

The above species are considered and figured below. The term *Cut-worm* is very loosely used, being often applied to the larva of the *June bug*, which cuts grass roots; to the *wire worms*, the larvæ of the snapping beetles, and even to the *borers* that cut channels in woody plants. The term cut-worm is principally confined by entomologists to larvæ of the Owlet Moths *(Noctuidæ)*, that have the habit of hiding just under the surface of the ground during the day and feeding upon the roots, stem or leaves of plants by night. When the larvæ climb high and feed upon the foliage of tall plants or trees, they are called *Climbing Cut-worms*.

The cut-worms may be known by the following general characters:

The moths known as *Dart Moths* or *Owlet Moths* are deltoid or triangular in shape (see Figs. 4, 6 and 7) when the wings are closed, and usually fly at night, and often enter rooms, being attracted by the light. The worms when full grown measure from one to two inches in length, have sixteen legs (three pairs of true legs and five pairs of prolegs), thick bodies which taper somewhat at the ends; without hairs and greasy looking, brown gray or greenish with indistinct longitudinal or oblique markings; head long, shining red or brown, head and anal segments armed above with a horny plate, darker than the remainder of the body. On each segment are six or eight dark colored humps, each bearing a hair. (See Fig. 6.) When disturbed the worms curl themselves into a ring as shown in Fig. 2. There are between three and four hundred American species related to the cut-worms and many species besides the above are numbered among the pests of the farm, garden and orchard.

THE VARIEGATED CUT-WORM.

Agrostis saucia (Hubner).

(Ord. Lepidoptera: Fam. Noctuidæ.)

DESCRIPTION.

Eggs—round, flattened, pink, prettily ribbed and ornamented, laid in patches of several hundred on the twigs of the apple, cherry and peach. Mr. Monroe's specimens were found on the *trunks* of *plum* trees. Fig. 1, *a*, represents an egg enlarged, showing the ribbing and ornamentation. Fig. 1, *b*, represents a cluster of the eggs, natural size, attached to a twig.

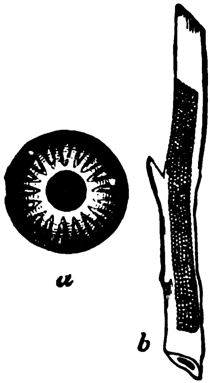


Fig. 1.

Larvæ, when young, dull yellow marked with darker spots. Full grown larva, dull flesh color, mottled with brown and black and elongated velvety black markings on the sides, large, when mature nearly two inches long. Fig. 2 shows the larva at rest and the head magnified to show the markings. The larvæ are mature in June, when they enter the ground form an oval cavity within which they change to the *chrysalis*, which is deep mahogany brown, pointed at the extremity, as shown in Fig. 3.

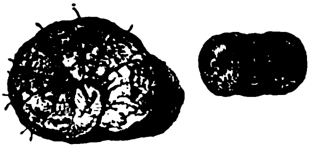


Fig. 2.

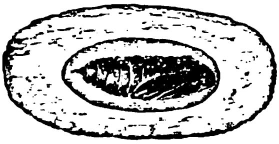


Fig. 3.

The *moth*, shown in Fig. 4, expands about one and three-quarters inches and the fore wings are grayish brown marked with brownish black; the hind wings are white and pearly, shaded toward the margin with pale brown. The moth is on the wing in July and lays its eggs as shown above.

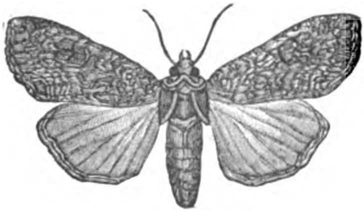


Fig. 4.

The Glassy Cut-worm.

Hadena devastatrix (Brace).

(Ord. Lepidoptera: Fam. Noctuidæ.

The eggs of this species and the egg-laying habit, so far as we know, are not known. Probably the eggs are laid on plants near the ground, which is the usual place of depositing them by cut-worms, and not in the ground, as formerly supposed. Brace, who originally described the moth, says the eggs are laid in autumn and hatch in May. The belief among entomologists now is that most cut-worms hatch in the fall and enter the ground, maturing the following spring.

Larva—length 1.8 inches, color translucent glassy green with a tinge of blue; head venetian-red, jaws black, a small black spot on each side, head shield distinct, hard, polished, dark brown; caudal plate not so well defined and pale. The larvæ is full grown the last of June and soon changes to the *chrysalis*, which is dark mahogany brown, attenuated at the end more than usual, two distinct slightly curved horns at the end with several stiff bristles around them. The larvæ is shown, Fig. 5, natural size; below the larva is one of the segments enlarged, showing the dots bearing hairs, usually found on cut-worms.

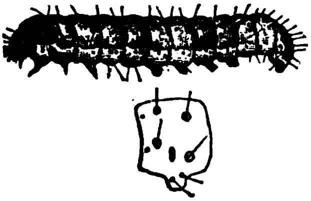


Fig. 5.

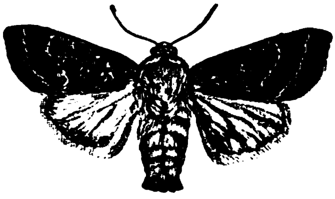


Fig. 6.

Moth—spread of wings from an inch and a half to an inch and three-fourths; fore wings grayish brown crossed with four more or less distinct white wavy lines, edged more or less with black; hind wings pale brownish gray. This species is on the wing in July. Those we transformed came out the third week in July. It is shown natural size in Fig. 6.

Feeding upon grass roots and corn in the hill, in Maine. Stalks of corn eight inches high were found cut by this species. Brace says it prefers beans, and several writers accuse it of cutting cabbage. It does not seem to be so abundant in Maine as the next species, though locally about Farmington, Auburn and Lewiston it did considerable damage the past season. This species is found in Canada and in the Southern and Middle States and we believe it has been found in Europe.

GREASY OR BLACK CUT-WORM.

Agrostis Ypsilon (Rott.)

(Ord. Lepidoptera: Fam. Noctuidæ.)

Eggs—pale fulvous; nearly spherical, base somewhat flattened; laid in small patches, often of two or three layers and sparsely covered with long scales from the abdomen of the female moth.

Larvæ when full grown about an inch and a half long, dull lead brown color with five longitudinal paler stripes; under side of body pale greenish yellow.

The *Moth*, Fig. 7, has dark fore wings with a bluish tinge on the front border and with a dark brown lance-shaped mark running from the posterior portion of a kidney-shaped spot in the middle of the wing. Hind wings pearly white and semi-transparent.

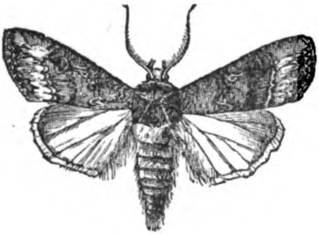


Fig. 7.

This species is world-wide in its occurrence and does great damage to garden and field crops. It has been found destroying cabbage, tomatoes, potatoes, tobacco, cotton, corn and beans. In confinement it will feed upon apple and grape leaves. There are two broods and the moths are on the wing from April to October. Those we reared emerged the last of August. It was found by Mr. Sleeper cutting corn, but more abundantly by him in potatoes. We bred the moths from worms taken in corn hills, but did not notice their work in potatoes near by.

REMEDIES.

The remedies may be divided into *natural* and *artificial.* Natural remedies are those provided by nature to hold insects in check and prevent their undue increase. Under this head would come *parasites*, like Ichneumons and Tachina flies, that lay their eggs in the worms and destroy them; *predaceous insects*, as various species of beetles, hemiptera, mites and spiders; *birds*, as the robin, catbird, blackbirds and poultry; and *quadrupeds*, as the skunk and probably moles, all of which eat them.

Artificial remedies are those devised by man to protect his crops, or destroy the insects feeding upon them. They may be divided into *preventive* and *destructive.*

Preventive are those that protect the plants from attack, but do not destroy the insects. *Destructive* are those that attempt to effectually remove the cause of the injury by aiming at the life of the insect.

PREVENTIVE REMEDIES.

a. Application of chemicals or other substances to the soil, which do not poison the worms but makes their food unpalatable. They do not seem to relish *salt* like the higher animals, and its use is highly recommended by Lintner and others. A handful is applied on the surface to each hill. Soaking the seed in *Copperas water,* one pound to the bushel of seed, allowing it to remain twelve hours, and then rolling it in plaster, would come under this head. This method is strongly recommended by Lintner. Tobacco has been used successfully to protect cabbage plants. It is put under the surface around the plants.

b. By protecting the plants so the worms cannot reach them. Under this head would come wrapping cabbage and other set plants with brown paper, burdock, walnut, or other leaves, or surrounding the base of the plants with tin or paper tubes or frames. Paper frames should be made broader at the top to prevent the worms crawling up the sides and set a little below the surface of the soil at the bottom. Tin tubes are much more durable. They can be made of slips of tin 2 in. by 10, bent in the form of a cylinder, and bent so as to loop at each end. They should be painted inside to prevent burning the plants by the sun. Bands can be made of tin and put around the base of fruit trees to protect them from climbing cut-worms.

Fitch recommended digging a shallow trench with perpendicular sides around the garden. This is based upon the belief that cut-worms travel to the cultivated ground from the adjoining meadows and pastures to feed upon the tender, cultivated plants.

c. By thick planting so as to have a good stand left after the worms have been fully fed. As Fitch expresses it, "plant one seed for the blackbird, two for the crow, three for the cut-worm and three to grow."

d. By dusting the foliage with dry powders like hellebore, ashes, or air slacked lime, to make it unpalatable to the worms.

DESTRUCTIVE REMEDIES.

a. Early plowing in the Fall. This destroys the weeds upon which the young worms feed and they starve. After summer crops are harvested the weeds are usually allowed to grow, giving the worms abundant food.

b. Late Fall plowing. This should be done after the worms have become torpid and have gone into winter quarters, so as to break the walls of the cells in which they hybernate, thus exposing them more fully to the changes of temperature.

c. Early Spring plowing and late seeding is supposed to cut off their food supply and starve them.

d. Late Spring plowing and seeding is supposed to give the worms a chance to mature on weed food and transform before the crop is planted.

e. Frequent cultivation of sod land is supposed to be beneficial. The moths lay their eggs upon plants near the ground. They deposit more eggs upon grass ground than elsewhere and the worms would accumulate in meadows. Turning every two years is advocated by some. Summer fallowing has been advocated in extreme cases.

f. Making deep holes about the hills with a dibble has been tried with good effect. For this purpose a sharpened stick about two inches in diameter is used. It can be thrust very rapidly deep in the soil once or twice near each hill. This makes a smooth, round hole into which the the worms fall and cannot get out, and they perish or eat each other. To make their death certain go over the field again the next day, thrusting the stick in the same holes to crush them.

g. Pouring solutions about the hills poisonous to the worms. Saltpetre has been used for this purpose and is said to destroy the worms and at the same time provide nitrogen food to the plants.

h. Dipping plants to be set in Hellebore Solution has been successfully used with tobacco plants. We have no record of its being tried for cabbage plants. One pound of Hellebore to ten gallons of water was used for tobacco plants.

i. Digging out the worms when the plants are seen to be affected by them. This is somewhat like locking the barn after the horse is stolen, but you have the satisfaction of destroying the perpetrator. Preventive remedies leave the worms to multiply over two hundred fold. Such a remedy as the above strikes a hard blow at the cause. This is a laborious method, but in connection with thick planting so a good stand will be left, it is effectual and largely practised.

j. Spraying the foliage with London purple, Paris green or Hellebore water will kill species that attack the foliage.

k. Shaking the trees or vines early in the morning and destroying the worms that fall has been recommended for climbing cut-worms.

l. Kerosene Emulsion has been successfully tried at the Dept. of Agric., Washington, D. C., for destroying root-eating grubs in grass grounds and would, without doubt, prove as effectual in killing cut-worms under similar circumstances.

For grass grounds we quote from Mr. Cogan's report to Prof. Riley (Insect Life, Vol. 1, No. 2, p. 49), the following: "The places affected were thoroughly drenched with an emulsion of kerosene in the proportion of one to sixteen, and the ground then well watered. I found that where this emulsion was used the grubs immediately ceased their depredations, penetrated further into the ground and not a live one was found to date after careful search, while in other places, where the emulsion was not used, they are still working in a lively manner." For the details of the experiment see periodical quoted above. The above method could be used to destroy the grubs of the May beetle as well as cut-worms.

We copy the formula for preparing kerosene emulsion from U. S. Dept. of Agric. Rept., 1884, p. 331, where further details may be found.

Kerosene, - - - - - -	2 gallons.	67 per cent.
Common soap or whale-oil soap, -	1-2 "	37 " "
Water, - - - - - - -	1 "	

Heat the solution of soap and add it boiling to the kerosene. Churn the mixture by means of a force pump and spraying nozzle for five or ten minutes. The emulsion, if perfect, forms a cream which thickens on cooling, and should adhere without oiliness to the surface of glass. Dilute the emulsion, before using, with nine parts of water. The quantities used above, when diluted, would make thirty gallons of wash. Prof. Riley urges the importance of proper emulsion, while Prof. Cook uses the following formula: Dissolve 1-4 lb. hard soap in two quarts boiling water, add 1 pint of kerosene and mix thoroughly. This should form a thick, cream-like mass. Before using, dilute with two gallons of water.

m. Killing the worms before the crop to be jeopardized is up, or the plants to be set are put out. There are several ways of accomplishing this end, known under the general names, ball trap system, and poison ball trap system. In all of these methods the land should be plowed early and the natural food of the worms destroyed. While they are starving, green food, as grass, clover, cabbage leaves, etc., may be put in bunches through the field. The worms collect to eat this food and crawl into the ground near by when done feeding or secrete themselves under the traps, and can readily be dug out or caught and killed. In the poison ball trap system the food is poisoned, thus saving the trouble of digging or searching for the worms.

Prof. Cook poisoned clover and then forked it from a wagon in small bundles, at intervals through the field. Prof. Riley recommends that the food will keep fresh longer if tied in balls or loose masses. Another party put poisoned cabbage and turnip leaves in rows fifteen to twenty feet apart through the field. The food can be poisoned with Paris green or London purple, preferably in suspension in water, though some have mixed it with plaster or flour.

THE COTTON-WOOD DAGGER.

Apetala lepusculina, (Gue.)

(Ord. Lepidoptera: Fam. Noctuidæ.)

The larva of the above species was received from Mr. W. F. Phinney, Standish, Me., and said to be feeding upon the leaves of the door-yard plantain. So far as we know, it has never before been reported as feeding upon species of *Plantago*. As the name indicates, it usually feeds upon the cottonwood, *Populus monilifera*.

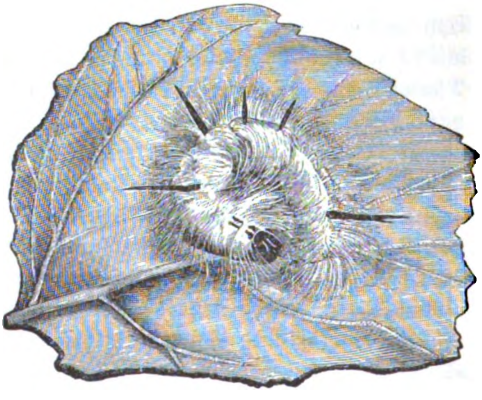


Fig. 8.

This species may be known by the following description:

Larvæ, when young, almost white with a distinct black dorsal line, short black tufts and sparsely covered with white hairs. When full grown, greenish yellow and thickly covered with long, soft, bright yellow hairs, which grow immediately from the surface and curl round the sides each way from the middle of the back; head black. There are two little black spots on the top of both the first and second segments, with a pale line between them. The top of segments 4, 6, 7, 8, 11, each bear a straight black brush of hairs. When at rest the larvæ remains curled upon the leaf as shown in Fig. 8. Our specimen agreed exactly with the above description in the number of black brushes, though some specimens have only three tufts, others six, and occasionally there are a few black hairs among the yellow on the body. Our specimens were received about August 1st, which would indicate the second brood, the first brood emerging in June. When grown the larvæ seek a sheltered place, chink in the bark of a tree or cap of fence, and change to a dark, shiny brown chrysalis, encased in a pale yellow cocoon composed of silk and hairs of the caterpillar. The insect passes the winter in the cocoon.

The *moth* has light gray fore wings with a broken black band near the margin and a few black spots in the middle. Hind wings white with black marks in the fringe.

THREE-TOOTHED APHONUS.

Aphonus tridentatus, Say.

(Ord. Coleoptera: Fam. Scarabidæ.)

Scarabæus tridentatus, Say, Jour. Acad. Nat. Sciences, Vol. 1, No. 2, June, 1817. Original description Say's Entomology, Vol. 11, p. 134. Proc. Acad. Nat. Sciences, 1856, pp. 21-23.

The technical description of the beetle as given by Say. is as follows:

Body black, punctured, clypeus, scabrous; an obsolete elevated abbreviated line in the middle; an elevated transverse tridentate line on the anterior submargin, confluent each side, with the lateral reflected edge; tip much narrowed, emarginate, reflected; thorax, punctures generally diffused; scutel impunctured; elytra with punctured striæ, beneath reddish brown. Length three-fifths of an inch. Described from a single specimen brought from Arkansas by Thos. Nuttall.

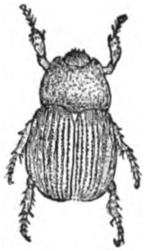


Fig. 9.

Popular Description of the beetle. Body black, thick set and about three-fifths of an inch long, head and thorax marked with small round pits. The head apparently ending in an upturned border bearing three teeth (the teeth are borne on the clypeus). The wing cases (elytra) each marked with about nine longitudinal pitted furrows, those on the edge obscure; legs stout, under side of body and legs reddish brown. The beetle is shown in Fig. 9, about one-fourth too large. The head is shown turned down so that the suture between the clypeus and epicranium does not show, and the teeth and the clypeus projecting forward appear in relief.

This species is distributed from Maine to Texas, but nothing is known of its habits or transformations. It has not before, so far as we can learn, been accused of doing injury to crops. The writer received specimens of this beetle the past season from Mr. Nathaniel H. Sleeper, Lewiston, Me., and from Mr. C. V. Manley, Auburn, Me. It was accused by both parties of cutting corn in the hill after the manner of the cut-worm. In the mouth of two witnesses the guilt would seem to be established.

Below we give the evidence found in the letters accompanying the specimens.

LEWISTON, ME., June 25, 1891.

To W. H. JORDAN, M. S. C:

Dear Sir:—I herewith send to you some samples of a corn destroyer that I found while hoeing my corn. What I want to know is whether the bugs I send are enemies or friends; whether the bug eats the corn, or whether he is after something that does. I found some ten or twelve of these bugs just by the stalks of corn and sometimes one or two inches under the surface, and sometimes there were two or three stalks eaten in one hill. In three instances I found the black cut or corn worm; once the worm and bug in the same hill, and one time a worm in the midst of the stalk eating his way up.

If you can put me in the way of saving the corn you will oblige me very much.

NATHANIEL H. SLEEPER.

When we received the above letter we were of the opinion that the cut-worms were entirely responsible and we wrote Mr. Sleeper to this effect and requested him to examine farther, and following is the response.

2ND LETTER.

LEWISTON, Me., July 1st, 1891.

F. L. HARVEY:

Dear Sir:—I received your letter last evening and thank you very much for it. I went out early this morning and dug into some hills of corn. In the first one found a beetle. Dug into a few more and found none, but found 24 hills of corn that had been dug into during the night. In some of them the roots had been all laid bare, and some only dug into at the side by some animal, I think a *skunk*. I suppose he was digging for beetles.

This evening I went out to the corn to look for worms and beetles. I dug into twenty hills; in nine of them I found the same beetle, in five were worms, in six were nothing found; in two of the five were worms in the stalk above the ground about 3 inches. The smallest one I send to you.

The large, dark colored one is he that eats off the stalk above ground and eats potato stalks and the beans more than he does the corn. The other two large ones were found where the stalk was eaten an inch below the surface, one in a place. These two are larger than others, and had the same appearance of those I found some days ago.

The largest black worm is seldom found in my corn; he is plenty in the potatoes. The two large, light colored ones I have found more plenty in the corn.

I send you a little box with some specimens.

Yours truly,

N. H. SLEEPER.

LISBON, ME., June 9th, 1892.

To F. L. HARVEY, ESQ.:

Dear Sir:—I received your letter a short time ago and was immediately called away, hence the delay, and will say that the ground was new land, was in grass for ten years, was never plowed before.

In the fall of 1890, I took out the stumps and stone—large pine stumps and lots of them. In many places the old forest mould was plenty. I think the beetle was a native of such places.

The manure was barnyard scrapings with Clark & Williams' superphosphate. I found no corn cut so low down where the cut-worm was. I found some cut-worms but not many; those that were cut (as I think) by the beetle were cut snug to the kernel or to the roots of the corn. You remember I wrote you the second letter; in that told you of twenty hills injured. If I remember, was six beetles found; some of them in close to the injured corn, though not quite certain of it. I feel certain he is the fellow that did it.

N. H. SLEEPER.

From the above evidence it seems certain that the beetles are in part responsible for the injury. This opinion is strengthened by the letters from another locality given below.

AUBURN, ME., June 27, 1891.

PROF. F. L. HARVEY:

Dear Sir:—I send you by this mail two beetles that we found eating the corn stocks, cutting them off just below the ground in the same manner as the cut-worm.

C. V. MANLEY.

AUBURN, ME., May 1892.

PROF. F. L. HARVEY,
Orono, Me.:

Dear Sir:—Your letter of the 23d received. The beetles that I sent you last season were found where barn manure was spread on the land and phosphate put in the hill. There were but very few cut-worms on the piece and not any in the hills where we found the beetles.

C. V. MANLEY.

As this beetle belongs to the same family as the May beetle and others that are found in the larval form in manure, probably it was introduced from that source. As its larvæ is not known nor any of its habits or transformations, nothing can be asserted regarding it. Efforts will be made to procure the larvæ and determine its changes. We know of no remedy better than killing the beetles when found.

PREDACEOUS WATER BEETLE.

Dytiscus verticalis, Say.

(Ord. Coleoptera: Fam. Dytiscidæ.)

The above species was unusually abundant the last season. Specimens were received from various places and several were found in the writer's yard in Orono, and several specimens caught by the cats, were taken from them. These insects are water-loving species and are attracted by moisture. Specimens sent by one party were found in the cellar among potatoes. The writer was much troubled by them in his cistern. The water got low and the cistern was filled from the river. The water was not strained and the larvæ probably introduced that way. In a few days the water began to smell and became very offensive. Several of the beetles were taken at various times from the valves of the pump. When water from streams is put in cisterns it should be filtered, and it would be well to keep cisterns closed during the time these beetles are on the wing.

The name *Dytiscus* means a diver and is given on account of the aquatic habits of the larvæ of these insects. The beetles may be known by their oval flattened form, brownish black color with a dull glaucous or sea green tint. The first and second pairs of legs are close together, the hind distant, set far back and used for swimming. The species in question is over an inch and a half long, black above with greenish reflections; thorax margined with yellow; elytra (wing covers) bordered with yellow excepting in front and near the hind margin bearing an oblique narrow yellow band.

The beetles, though larger, are related to the gyrating beetles often seen in large flocks playing on the surface of water and called lucky bugs by the boys. The larvæ are aquatic and are the terror of the ponds and streams, likened to sharks among higher animals.

The Parallel Elaphidion.

Elaphidion parallelum, Newm.

(Ord. Coleoptera: Fam. Cerambycidæ.)

This comparatively rare insect was received from Mr. Burgess of Monroe, in the larval form found boring into the twig of a plum tree. Though of rare occurrence it is interesting enough to figure so it may be recognized when seen.

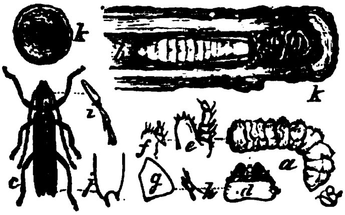


Fig. 10.

Fig. 10 *a* shows the larva, *b* a longitudinal section of the stem exposing the chrysalis in place, *k* a cross section of the chrysalis showing the boring, *d*, *e*, *f*, *g* and *h* head and mouth part of the larva, *i* the antenna of the beetle, *j* tip of the wing case. The beetle may be known by its dull brown color. It is a little over a half inch long. The eggs are laid in the axils of leaf buds. The young larvæ bore into the twigs enlarging the channels as they grow and when mature enter the chrysalis state in the stem and in due time emerge as beetles.

THE BROWN PTINUS.

Ptinus brunneus, Durfs.

Ord. Coleoptera: Fam. Ptinidæ.

The above named family embraces a number of minute species of beetles that do much injury, some boring into fruit trees, others into furniture, while others love animal food and injure hams, museum specimens, leather bound books and clothing.

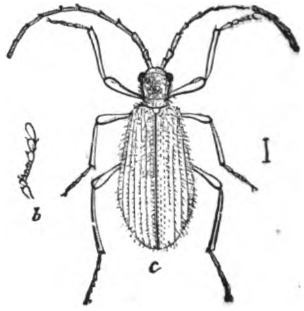


Fig. 11.

The genus *Ptinus* may be known by having the head and thorax much narrower than the wings (elytra); the antennæ about as long as the body, filiform not enlarged or branched. The species *P. brunneus*, Durfs., is only one-eighth of an inch long, dark brown and convex above, thorax narrower behind, densely covered with minute hairs. It is interesting in connection with the correspondence given below. The insect enlarged is shown in Fig. 11, the real size being indicated by the hair line at the right.

CALAIS, Maine, Jan. 8th, 1891.

TO PROFESSOR BALENTINE, Orono:

Dear Sir:—To your address I send by to-day's mail a tin box of red pepper. It has been in our possession since March, 1888. The label, which I did not notice particularly, and unfortunately destroyed when I opened the box, was not removed until recently. The pepper is, as you see, infested with bugs. The box has been subject to all the extremes of our climate, and if the bug would feed upon our vegetation might become a troublesome pest. I hope that I have not foolishly intruded upon your time.

Respectfully,

MRS. ESTHER GARDNER,
Calais, Maine.

Orono, Me., Feb. 1, 1891.

Mrs. Esther Gardner,
Calais, Me.

Dear Madam :—The box of infested red pepper which you sent to Prof. Balentine proved to be too tearful a subject for his consideration, and was turned over to me. I have wept, sneezed and delayed, but finally have summoned courage sufficient to examine the material and am now able to name the beetles you sent, which possess such strong stomachs and peculiar tastes. I have wondered while I have cried and sneezed, whether they have optic and olfactory nerves as sensitive as mine.

The beetles were probably not in the pepper when you bought it, as they are *Ptinus brunneus*, Durfs., a common, *indigenous* species known to feed upon wood, or sometimes on old books. I believe it has never been reported as feeding on red pepper. It must have found these conditions congenial as there were plump live larvæ of several ages with the beetles in the box. The above species is a brother to Ptinus fur, L., an imported European species that attacks museum specimens and sometimes clothing. The species mentioned with others belong to the Family *Ptinidæ*. Your conscience can be at ease. You have not turned loose in Maine an insect previously unknown to our fauna, for *Ptinus brunneus* is an *American*, besides, he does not aspire to growing vegetation for food but is content with dead vegetable and animal matter.

Yours very tearfully,

F. L. Harvey.

The Goldsmith Beetle.

Cotalpa lanigera.

Ord. Coleoptera: Fam. Scarabæidæ.

This beautiful beetle, which is shown about natural size in Fig. 12, may be known by its broad oval shape; lemon yellow color above, head and thorax glistening like burnished gold; the under side of the body coffee-colored and thickly covered with whitish wool; legs brownish yellow or brassy and shaded with green. The larvæ of this insect is a large grub that feeds upon the roots of plants. It has been accused of injuring strawberries. It is shown natural size in Fig. 13. It requires three

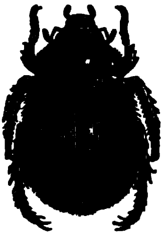


Fig. 12.

years to mature and resembles the grub of the May beetle.

Having received several letters accompanied by specimens of this insect, we give below one received the past season, with the reply, for the benefit of others who may need similar information.

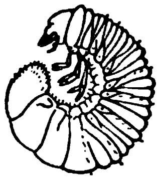


Fig. 13.

FRYE, Maine, June 26th, 1891.

STATE COLLEGE,
Orono, Maine:

I send a specimen of Beetle which I have never seen before in this State. Please examine it. It is sent in a tin box package.

Yours truly,
ALLEN REED,
Frye, Maine.

MR. ALLEN REED,
Frye, Maine:

Dear Sir:—The specimen you send is the Goldsmith-beetle, known to entomologists as *Cotalpa lanigera*, L., Family *Scarabæidæ*. This insect, in the perfect or beetle stage, feeds upon the leaves of trees, especially the pear, though other trees, as the elm, hickory, poplar and oak are subject to its attacks. During the middle of the day the beetles hide in the trees on the under side of the leaves, and are on the wing in the evening and morning twilight. The beetles come out of the ground in May and June. When abundant they do considerable damage to the foliage of trees, but they are so scaree in Maine we need not be concerned regarding them. This beautiful beetle always claims attention when found. We have specimens from the Kennebec valley and farther west in the State, but have never found or heard of a specimen being taken in the Penobscot valley or eastern part of the State. Will be pleased to answer any further questions you may ask regarding insects.

Yours truly,
F. L. HARVEY.

REMEDIES FOR BORERS.

Mr. Rutillus Alden called our attention to an orchard in Winthrop, Me., owned by Mr. Dexter Remick, that was coming into bearing and had been kept entirely free from borers by rubbing the trunk of the tree with the hand, while other orchards in the vicinity were infested. Regarding the matter of importance, we addressed some questions to Mr. Remick and condense the following facts from his reply: "My trees, Baldwins and Benonies, are five years old and just commencing to bear. They are planted on sandy loam and have been well fertilized with manure about the roots and are vigorous. My orchard is younger than my neighbors'. There are orchards within a short distance of mine. My trees have never been scraped but are naturally smooth and I have never applied any washes to protect them from borers.

I rub the trunks well with the hand twice every season, once in June and again in September. I rub as low as possible and to some height on the trunk." We tried to secure some larvæ of borers from the adjoining orchards, so as to learn which species of borer was common in the region, but did not. Under the circumstances we are not able to decide regarding the efficacy of the remedy. We see no reason why rubbing about the crown and lower part of the trunk would not destroy the eggs or newly hatched larvæ of the *Round-headed Borer*, (see Station Rept. 1888, p. 153.) The trunk would have to be free from crevices and the rubbing done at the right time, to prove effectual. We see no special efficacy in the hand and think a stiff brush would be better. If it is the *Flat-headed Borer* (see Station Rept., 1888, p. 155) that is working in the adjoining orchards and the above species rare, the vigor of the trees would protect them, as this borer usually prefers sickly trees, and as it lays its eggs on the *branches* as well as *anywhere* on the trunk, rubbing the base of the trunk would not protect the tree. We hope to get some of the larvæ this season.

We have noticed somewhere another remedy that seems to be simple and apparently practical for the *Round-headed Borer*, viz: to dig away the dirt an inch or two at the base of the tree, then tie around it a piece of thick paper, allowing it to extend a foot or more up the trunk; then put the dirt back. This arrangement prevents the beetle reaching the crown to lay its eggs. The paper should be left on the tree during the time the beetles are on the wing, that is from June to August. The paper could be poisoned with Paris green. Wrapping in this way is also advised to protect trees from rabbits.

BREEDING STATISTICS.

Dr. F. L. Russell.

The material for these statistics was obtained by sending out blank forms to farmers all over the state. The animals reported on were grades and full bloods of all the more common breeds of cows and also comprise a large proportion of "natives."

It is evident that the value of such statistics as these depends upon the number of animals upon which they are based, and the accuracy of the data. We make this brief report from the material at hand, hoping that it may awaken such an interest in the subject that a larger number than have heretofore done so will fill out and return to me the blanks that will be mailed them each year. This is a matter of general interest to farmers and stock breeders and we would urge upon them the importance of filling out the enclosed blanks as fully as possible. It is desired that the weight of the calves shall be taken within twenty-four hours of birth. Where conveniences are not at hand for doing this, that item may be omitted, as an estimated weight is not sufficiently accurate. We particularly desire that the last item on the blank should be carefully considered. We would decide the period of heat so as to include six or eight hours in the first part, the last six or eight hours in the last part, and the rest we would regard as the middle part of heat.

The reports that have already been received indicate that there may be some relation between the time of service and the sex of the calf. If this should prove to be true, it is a matter of considerable importance and we desire that great care be taken to correctly record the time of service.

The average period of gestation for 257 cows reported was three and one-half hours over forty weeks or 281.72 days. For the bull and heifer calves the average time was practically the same, for the bulls 281.74 days and for the heifers 281.69. The shortest period, 243 days, resulted in a heifer calf. The two longest periods were 303 and 304 days and the calves were both bulls. Of the 257 calves 135 were bulls and 122 heifers.

Of the 113 calves of which the weight at birth was given, the average weight is found to be 73.62 lbs. The average weight of

58 bull calves was 76.80 lbs., and of 55 heifer calves 70.11 lbs. The bull calves averaged 6.69 pounds the heavier. The heaviest and lightest calves were both heifer and weighed 122 and 40 pounds respectively.

Eighty-two cows were reported as having been served during the first part of their heat, and they produced thirty-one (37.8 per cent.) bulls and fifty-one heifers (62.2 per cent.)

Of seventy-six cows served during the last part of their heat, forty-two, or 55.26 per cent. produced bull calves and thirty-four (44.74 per cent.) produced heifers.

SUMMARY.

DURATION OF PERIOD OF GESTATION OF 257 COWS.

Maximum period	304.00	days.
Minimum "	243.00	"
Average when calf was a bull	281.74	"
Average when calf was a heifer	281.69	"
General average	281.72	"

WEIGHTS OF 113 CALVES AT BIRTH.

Maximum weight	122.00	lbs.
Minimum weight	40.00	"
Average weight of bull calves	76 80	"
Average weight of heifer calves	70.11	"
General average	73.62	"

RELATION OF THE TIME OF SERVICE OF 158 COWS TO THE SEX OF THE CALVES.

82 cows served during the first part of heat produced
31 bull calves and 51 heifer calves.
76 cows served during the last part of heat produced
42 bull calves and 34 heifer calves.

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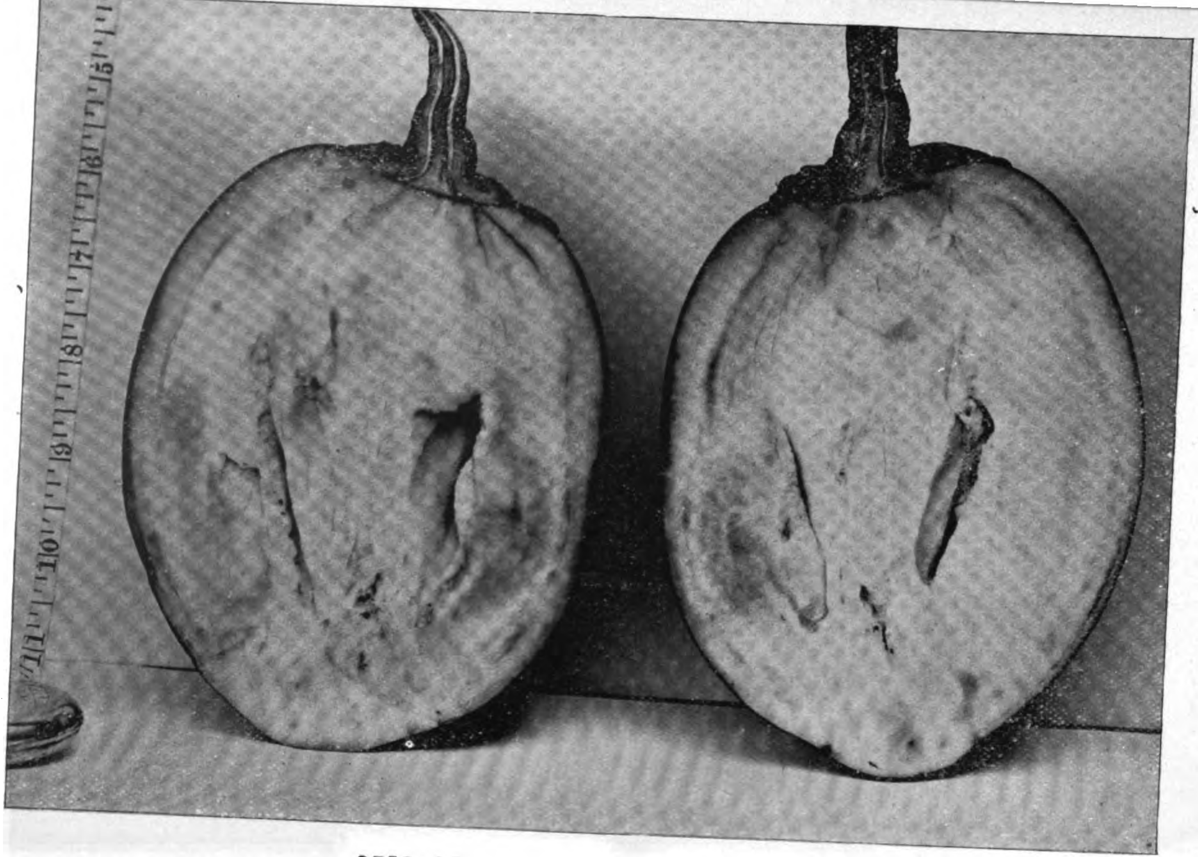

SEEDLESS EGG FRUIT. See Page 46.

ANNUAL REPORT

OF THE

MAINE STATE COLLEGE

AGRICULTURAL EXPERIMENT STATION

ORONO, MAINE.

1892.

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AGRICULTURAL EXPERIMENT STATION.

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F. L. **Russell**, V. S.,	Veterinarian to Station.
W. M. **Munson**, B. S.,	Professor of Horticulture.

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H. P. **Gould**,	Assistant in Horticulture.
A. M. **Shaw**,	Foreman on Farm.
Mrs. J. **Hamlin Waitt**,	Stenographer and Clerk.

TREASURER'S REPORT.

THE MAINE AGRICULTURAL EXPERIMENT STATION.

In account with

THE UNITED STATES APPROPRIATION.

RECEIPTS.

From the Treasury of the United States as per appropiation for the year ending June 30, 1892		$15,000 00

EXPENDITURES.

Chemical Laboratory	$ 434 54	
General Expense	297 77	
Field and Feeding	790 34	
Horticultural Department	793 34	
Head House	468 93	
Library	62 97	
Printing	1,667 35	
Stationery and Postage	108 00	
Travelling Expenses	147 00	
Trustee Expenses	50 40	
Construction and Repairs	277 19	
Botany and Entomology	33 50	
Fertilizer Inspection	209 16	
Meteorology	20 50	
Veterinary Science	28 46	
Fuel Account	294 45	
Salaries	9,316 10	
		$15,000 00

I hereby certify that the above is a correct statement of the amount expended by the Maine Experiment Station for the year ending June 30, 1892.

GEO. H. HAMLIN,
Treasurer of Trustees, Maine State College of Agriculture and the Mechanic Arts.

I hereby certify that I have examined the accounts of the Maine Experiment Station for the fiscal year ending June 30, 1892: that I have found the above to be a correct statement of expenditures both as to amount and classification, for all of which proper vouchers are on file.

HENRY LORD,
Audtior of the Trustees, Maine State College of Agriculture and the Mechanic Arts.

I hereby certify that the above are the signatures of the Treasurer and Auditor of the Trustees of the Maine State College of Agriculture and the Mechanic Arts.

W. H. JORDAN,
Director of Station.

DIRECTOR'S REPORT.

M. C. Fernald, Ph. D., President Maine State College:

SIR:—The work of the Maine Experiment Station for the year 1892, a report concerning which I have the honor to submit herewith, has been conducted along the lines previously established. It has included the following: 1st, inspection of fertilizers; 2d, analyses of cattle foods, including certain patent foods which are offered for sale at greatly advanced prices. An attempt has been made to demonstrate to the farmer the very poor economy of purchasing the latter. 3d, investigations concerning the secondary effects of pollination. In presenting these results, Prof. Munson has taken the occasion to collect in the form of a monograph all the avilable information which has been published on the subject. 4th, experimental work on varieties and methods of treatment of certain garden vegetables, including cabbages, tomatoes and egg plants. 5th, contents, cultivation and care of small and large fruits which are being tested. 6th, spraying experiments, specially with reference to the apple scab and codling moth. 7th, the identification and description to inquirers of such injurious plants and insects as are sent to the Station. 8th, investigations in plant nutrition bearing upon the economical use of crude fertilizing materials. 9th, digestion experiments. 10th, feeding experiments with swine and milch cows.

PUBLICATIONS OF THE STATION.

The publications of the Station by means of which the results of the above experiments and investigations are set forth have consisted of a report issued in five parts. In this report have been included everything excepting the digestion and feeding experiments. These have so far been in the immediate charge of the Director of the Station, but owing to increased duties in connection with the World's Fair, he has not been able either to undertake the past season as extensive experiments or to report them as promptly as otherwise would have been the case. Only a limited edition of Part 2, of the report (Secondary Effects of Pollination) was issued as it was sent out only to newspapers, experiment stations and experiment station workers. The reason

CALI

for this was that the publication was of a strictly scientific nature and while presenting the results which it is hoped will lead to practical conclusions eventually, its contents were of such a nature as to be of little general interest. Besides the five parts of the station report, there was also issued a bulletin on the Babcock Milk Test and six newspaper bulletins, the latter being designed as a concise and simple statement of the outcome of certain practical experiments.

STATION EXHIBIT AT THE COLUMBIAN EXPOSITION.

At a meeting of the association of colleges and experiment stations held at Champaign, Ill., in November, 1890, it was voted that the experiment stations unite with the United States Department of Agriculture in making a co-operative exhibit at the Columbian Exposition. A committee of five was appointed to act in conjunction with the Central Office of Experiment Stations in forming and executing plans for this exhibit. It was decided that instead of inviting each experiment station to make an individual exhibit, thus causing very much of repetition, it would be better to co-ordinate the total exhibit into sections, each section to represent a particular subject. I was invited to take immediate charge of the section devoted to Animal Nutrition and after consultation with yourself agreed to do so. It was evident from the first that because of the nature of this subject, the exhibit could not consist so much of objects of special interest as of a graphic display of results. For instance, it was very evident that the main factor of the exhibit must be a display of the relation of food and growth under varying conditions, and if such a display were to mean anything as an expression of the work of American experiment stations, it must be based upon their experimental data. This necessitated the review of all the station literature bearing upon experiments in animal nutrition. All the experiment stations that had conducted feeding experiments were invited to assist in this work, and some of them very kindly furnished the data of their own feeding experiments so arranged and digested as to be immediately useful in obtaining certain necessary general averages. The required data from swine feeding experiments were very kindly furnished by the Office of Experiment Stations from manuscript prepared by Dr. Armsby, of State College, Pa.

In order to obtain the necessary figures pertaining to milk production and the growth of bovines and sheep, there were used the results of one hundred and twelve feeding experiments made by American stations. As before stated, many of these results were put into the desired form by the stations making the experiments, but considerably more than half of them were worked up in this office from the original data. Moreover, a large part of the exhibit itself has been prepared here. All of this required my personal attention. I make the above statements as an explanation why that line of experimental work in which I am immediately interested has been to some extent neglected.

INSPECTION OF FERTILIZERS.

As in previous years, the time of the station force has in part been devoted to the inspection of fertilizers. There is a fair prospect that this will not again be done at the expense of the funds supplied by the United States Government. It now appears probable that the Legislature soon to meet will be asked to enact a law which will provide for the expense of this inspection either by direct appropriation from the State, or by requiring a license fee from fertilizer manufacturers doing business in the State. The movement in this direction has the approval of members of the Board of Agriculture and of others who understand the exegencies of the case.

WORK IN PLANT NUTRITION.

Through you I desire to urge upon the attention of the Board of Trustees a proposed enlargement of our work in plant nutrition. Since the establishment of the Experiment Station under the provisions of the Hatch Act, the experiments and investigations in plant feeding have been under the immediate charge of Prof. Balentine. He has attempted to reach beneficial results through field experiments on the College Farm, through experiments conducted by farmers in different parts of the State, and through more or less experimentation in pots with a view to a more exact work than can be done in the field.

It is very evident and has been for some time that not only are the errors of field experimentation very large, but that the usefulness of this method of work is limited to the testing of theories as to the correct methods of maintaining fertility. An exact study of the fact and principles of plant nutrition must be accomplished by some other method. It is a noticable fact that American Experiment Stations are giving comparatively little attention to this subject, at least in the way of rigid scientific investigation, and an inviting and important field of work seems to be open. The nutrition of animals has received a much larger amount of attention.

Experiments now under way in the forcing house give promise of a far greater degree of success than has been possible under previously existing conditions and Prof. Balentine is desirous that there shall be erected a new forcing house which shall be entirely utilized, for a time at least, by experiments of this kind. This idea has my most hearty endorsement and through you I wish to urge upon the trustees the importance of developing this line of investigation. The present forcing house is entirely inadequate to accommodate any additional experiments. As this new forcing house would stand in a prominent place, it should be somewhat more ornamental than the one already built, and not less than $1,500 should be available for its construction.

ACKNOWLEDGEMENTS.

The Experiment Station is under obligation to the following parties for gifts of various kinds:

DONATIONS 1892.

O. M. Lord, Minnesota City, Minn., apple cions.

J. S. Harris, La Crescent, Minn., apple cions.

C. G. Patten, Charles City, Iowa, apple cions.

Jewel Nursery Co., Lake City, Minn., 6 Thompson Seedling Apple Trees; 6 Windom Dewbery; 6 North Star Currants.

Ellwanger & Barry, Rochester, N. Y., specimen fruits of autumn pears.

Field Force Pump Co., Lockport, N. Y., 1 Little Gem spraying pump.

The following newspapers and other publications are kindly donated to the Station by the publishers during 1892:

Farmers' Home, Dayton, Ohio.
Holstein Friesian Register, Boston, Mass.
Farm and Home, Springfield, Ill.
Jersey Bulletin, Indianapolis, Ind.
Monthly Bulletin, Philadelphia, Pa.
Farmers' Advocate, London, Ont.
Maine Farmer, Augusta, Me.
Southern Cultivator, Atlanta, Ga.

American Dairyman, New York, N. Y.
The Pharmaceutical Era, Detroit, Mich.
The Sun, Baltimore, Md.
Massachusetts Ploughman, Boston, Mass.
Practical Farmer, Philadelphia, Pa.
New England Farmer, Boston, Mass.
Louisana Planter, New Orleans, La.
Mirror and Farmer, Manchester, N. H.
Texas Farmer, Dallas, Texas.
Hoard's Dairyman, Ft. Atkinson, Wis.
Iowa Farmer and Breeder, Cedar Rapids, Iowa.
Detroit Free Press, Detroit, Mich.
Orange County Farmer, Port Jervis, N. Y.
Farm Journal, Philadelphia, Pa.
Delaware Farm and Home, Wilmington, Del.
The Western Rural, Chicago, Ill.
American Cultivator, Boston, Mass.
Farmers' Review, Chicago, Ill.
The Rural Canadian, Toronto, Ont.
Vick's Magazine, Rochester, N. Y.
The Farm and Dairy, Ames, Iowa.
The Clover Leaf, So. Bend, Ind.
New York World. (weekly)
The Grange Visitor, Lansing, Mich.
The Industrial American, Lexington, Ky.
The American Grange Bulletin and Scientific Farmer, Cincinnati, Ohio.
Agricultural Epitomist, Indianapolis, Ind.
The Prairie Farmer, Chicago, Ill.

W. H. JORDAN,
Director.

MAINE STATE COLLEGE,
ORONO, ME., Dec. 31, 1892.

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INSPECTION OF FERTILIZERS.

The inspection of fertilizers by the Maine Experiment Station for the year 1892 has required the analysis of seventy-four brands of mixed fertilizers involving the selection of one hundred and ninety samples. In order to secure these samples, it has been necessary to send an agent into nearly every section of the State. Samples were taken in forty one cities and townships, often at several points in the same township. An effort is made to begin this work in March, but it is usually found that new goods have been shipped to but few places so that a successful canvass of the State can not be carried on until April, therefore the completion of the sampling and analytical work can not be reached until late in June. It will be noticed that three samples of each brand have not been secured in all cases.

In general this has been owing to the following causes: Selling of the fertilizer at but very few points, and finding only the goods held over from last year's sales in the hands of nearly all the agents visited.

SELECTION OF SAMPLES.

Samples for 1892 were selected by Mr. S. H. T. Hayes, an agent of the Station, acting under its instructions. The samples were drawn from three or four packages, mostly one hundred pound bags, so that in all cases where three samples were taken the analysis represents from nine to twelve packages of the goods. In some cases as many as five samples were taken.

The drawing of the samples is accomplished by means of a sampling tube which can be made to reach every portion of the package, and as several drafts are made from each package, it is readily seen that the method of taking samples is a very thorough one, and there is no good reason for supposing that the contents of the glass jar that is forwarded to the Station do not fairly represent the goods sampled. In every instance a sample exactly similar in composition to the one taken to the station is left in the hands of the agent selling the goods, thus giving the manufacturers an opportunity, by procuring an analysis of this sample, to check the analytical work of the Station.

THE TRADE VALUES OF FERTILIZERS FOR 1890.

The trade values given below which are used by this Station are those "agreed upon by the experiment stations of Massachusetts, New Jersey, Rhode Island and Connecticut for use in their respective states during 1892. The valuations obtained by use of the following figures will be found to agree fairly with the *average retail price* at the large markets of standard raw materials such as:"

Sulphate of Ammonia,
Nitrate of Soda,
Dried Blood,
Muriate of Potash,
Sulphate of Potash,
Azotin,
Ammonite,
Dry Ground Fish,
Bone or Tankage,
Ground So. Carolina Rock,
Plain Superphosphates.

	Cts. per lb.
Nitrogen in ammonia salts	17½
nitrates	15
Organic nitrogen in dry and fine ground fish, meat and blood	16
in cotton seed meal and castor pomace	15
in fine bone and tankage	15
in fine medium bone and tankage	12
in medium bone and tankage	9½
in coarser bone and tankage	7½
in hair, horn shavings and coarse fish scrap	7
Phosphoric acid, soluble in water	7½
" in ammonium citrate	7
in dry ground fish, fine bone and tankage	7
in fine-medium bone and tankage	5½
in medium bone and tankage	4½
in coarser bone and tankage	3
Potash as high-grade Sulphate and in forms free from Muriate or Chlorides	5½
as muriate	4½

"These trade values are the average prices at which in the six months preceding March the respective ingredients could be bought at retail for cash in our large markets, Boston, New York and Philadelphia, in the raw materials which are the regular source of supply. They also correspond to the average wholesale prices for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations."

The sale of "standard raw materials" in Maine is too small to allow an estimation of values upon the basis of local market prices, so the figures as agreed upon in other New England States, where the subject is very ably and thoroughly studied, are taken for use by this Station.

THE VALUATION OF SUPERPHOSPHATES AND MIXED GOODS.

These trade values are applied to the valuation of Superphosphates and all mixed goods, as follows:

It is assumed that the organic nitrogen of these goodhass for its source such materials as dried blood, ground fish, or nitrogenous substances of equally good quality, unless a special examination of some particular brand shows that inferior material like leather has been used. Organic nitrogen in mixed goods is therefore valued at sixteen cents per pound. As nitrogen in nitrates is rated for 1892 at only a cent less per pound than organic nitrogen, and as with but few exceptions the nitrates are present in very small quantities, no difference has been made in computing the "estimated value" between organic and nitric nitrogen, but both have been valued at sixteen cents. The small increase in the "estimated value" thus caused, while slightly favorable to certain manufacturers, can certainly do the consumer no serious harm. The nitrogen present in ammonia salts is reckoned at seventeen and one-half cents.

The insoluble phosphoric acid of mixed fertilizers is reckoned at two cents per pound, coming as it does largely from mineral phosphates, and in any case being much the least valuable portion of the original material.

The potash is valued at the price of that ingredient in the muriate, unless the chlorine present in the fertilizer is not sufficient to combine with it, in which case the excess of potash is reckoned at the price of the sulphate.

The valuation of a fertilizer is obtained by multiplying the percentages of the several ingredients by twenty (which gives the pounds per ton), and these products by the prices per pound, and the sum of the several final products is the market value of the fertilizing ingredients in one ton. For instance the "station valuation" of fertilizer No. 855 was obtained as follows:

2.65% Nitrogen,	53. lbs. per ton	@ 16 cts.	—$8.48.
6.26% Soluble Phos. Acid,	125.2 " " "	@ 7½ "	— 9.39.
3.80% Rev. " "	76. " " "	@ 7 "	— 5.32.
1.22% Insol. " "	24.4 " " "	@ 2 "	— .49.
1.77% Potash,	35.4 " " "	@ 4½ "	— 1.59.
		Valuation,	$25.27

Change in Method.

In past years separate analyses have been made of the samples representing the same fertilizer. At present equal quantities of all the samples are mixed, and an analysis of this mixture is assumed to give the same result as would be reached by averaging the analyses of the several samples, a method which is undoubtedly correct.

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Dealer.	Selling Price.
997	Alkaline Bone	E. Frank Coe, New York, N. Y.,	W. P. Bessey, Freedom	
855	Americus Amm. Bone Superphosphate	Williams & Clark Fert. Co., New York, N. Y.,	S. D. Edwards, Oxford	$36.00
868			Carleton Bros., Portland	32.00
963			L. A. Knowlton, Belfast	35.00
869	Americus Corn Phosphate	Williams & Clark Fert. Co., New York, N. Y.,	Carleton Bros., Portland	32.00
959			E. B. Gardiner, Bucksport.	
974			L. A. Knowlton, Belfast	36.00
957	Amm. Bone Super. (Standard Grade)	E. Frank Coe, New York, N. Y.,	Morrison & Joy, Ellsworth	36.00
981			A. A. Howes, Unity	
986			S. L. Small, Dexter	32.00
859	Bay State Fertilizer for Seeding Down	Clark's Cove Fert. Co., New Bedford, Mass.,	A. A. Mitchell, Portland	
971			L. A. Knowlton, Belfast	27.00
1017			J. L. Bridgham, No. Auburn	
990	B. D. Sea Fowl Guano	Bradley Fertilizer Co., Boston, Mass.,	L. F. Ireland, Corinna	31.00
1029			Willis Cobb, Winthrop	
1035			Steward Bros., Skowhegan.	30.00
853	Bowker's Amm. Bone Fertilizer	Bowker Fertilizer Co., Boston, Mass.,	S. P. Wardwell, Ea. Oxford	
995			Edwin Chick & Co., Bangor	35.00
1034			Steward Bros., Skowhegan.	35.00
1027	Bowker's Farm and Garden Phosphate	" " " " "	F. L. Butler, Farmington	

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Dealer.	Selling Price.
897	Bowker's Hill and Drill Phosphate......	Bowker Fert. Co., Boston, Mass.,	F. R. Benson, Turner's Cor.	
938			Co-operative Store, Dexter.	$36.00
1003			A. W. Ward, Thorndike...	33.00
852	Bowker's Potato Manure,......................	Bowker Fert. Co., Boston, Mass.,	S. P. Wardwell, Ea. Otisfield	
944			E. E. Parkhurst, Presque I.	38.00
952			Hiram Smith, Houlton.....	38.00
951	Bowker Potato Phosphate......................		Hiram Smith, Houlton.....	36.00
1010	Bowker's Square Brand Bone and Potash......		B. F. Curtis, Richmond....	27.00
1028			J. P. Merrill, Auburn......	27.00
1004	Bowker's Sure Crop Bone Phosphate......		A. W. Ward, Thorndike...	28.00
947	Bradley's Com. Manure for Potatoes and Veg't'le	Bradley Fert., Co., Boston, Mass.,	A. H. Fogg & Co., Houlton.	40.00
979			A. A. Howes, Belfast......	
1038			R. B. Dunning, Bangor....	40.00
873	Bradley's Eureka Seeding Down Fert....		Kendall & Whitney, Portl'nd	26.00
914			Hunter&McMaster, Pittsfield	
915			R. B. Dunning, Bangor.....	26.00
857	Bradley's Potato Manure......................		Hawkes& Whitney, M'c F'lls	36.00
874			Kendall & Whitney, Portl'nd	34.00
906			Cunningham & Sager, Gard.	36.00
918			Hunter&McMaster, Pittsf'ld	
924			L. K. Cary, Fort Fairfield..	38.00

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Dealer.	Selling Price.
858	Bradley's X. L. Superphosphate	Bradley Fertilizer Co., Boston, Mass.	G. O. Goodwin, Mech. Falls	36.00
872			Kendall & Whitney Portln'd	34.00
905			Cunningham & Sager, Gard'r	36.00
936			Carl Ullric, Caribou	36.00
991			F. L. Ireland, Corinna	34.00
863	Clark's Cove Bay State Fertilizer	Clark's Cove Fertilizer Co., New York, N.Y.,	A. A. Mitchell, Portland	
907			W. M. True, Waterville	36.00
920			D. Morrill, Bangor	34.00
928			L. K. Cary, Fairfield	38.00
848	Clark's Cove Bay State G. G		Benj. Tucker, Norway	30.00
860			A. A. Mitchell, Portland	
921			D. Morrill, Bangor	32.00
903			Robert Pope & Co., Gardin'r	35.00
879	Cleveland Potato Phosphate	Cleveland Dryer Co., Boston, Mass.,	Carleton Bros., Portland	32.00
901			F. P. Morrill, Gardiner	
1022			E. H. Libbey, Auburn	31.50
878	Cleveland Seeding Down Fertilizer		Carleton Bros., Portland	30.00
900			F. P. Morrill, Gardiner	
1015			E. H. Libbey, Auburn	26.50
880	Cleveland Superphosphate		Carleton Bros., Portland	32.00
902			Geo. H. Pope, Gardiner	
1016			E. H. Libbey, Auburn	1.50

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Dealer.	Selling Price.
889	Crocker's Corn Phosphate	Crocker Fert. & Chem. Co., Buffalo, N. Y.,	Geo. H. True, Freeport	
976			L. A. Knowlton, Belfast	$36.00
1008			B. F. Curtis, Richmond	36.00
1046	Concentrated Phosphatic Rock	Cumberland Bone Co., Portland,	College Farm, Orono	
849	Cumberland Superphosphate		Benj. Tucker, Norway	32.00
875			Cumb'l'd Bone Co., Portland	30.00
916			R. B. Dunning, Bangor	32.00
917	Cumberland Potato Fertilizer		R. B. Dunning, Bangor	36.00
933			A. L. Haines, Fort Fairfield	36.00
941			W. H. Bragdon, Perham	36.00
942			E. E. Parkhurst, Presque I.	36.00
877	Cumberland Seeding Down Fertilizer		Cumb'l'd Bone Co., Portland	25.00
966			L. A. Knowlton, Belfast	
996			E. Conforth, Thorndike	26.00
892	Dirigo Fertilizer	Sagadahoc Fertilizer Co.,	Sag. Fert. Co., Bowdoinham	25.00
911			A. R. Smith, Clinton	26.00
987			Geo. A. Tibbetts, Corinna	26.00
918	Farrar's Potato Phosphate	F. S. Farrar & Co., Bangor Me.,	Whitney & Cameron, Bangor	34.00
919	Farrar's Superphosphate		Whitney & Cameron, Bangor	32.00
1041			K. Pooler, Stillwater	35.00

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Dealer.	Selling Price.
881	Grass and Grain Fertilizer	E. Frank Coe, New York, N. Y.,	S. H. Fitz, Freeport	
958			Morrison & Joy, Ellsworth	$29.50
980			A. A. Howes, Unity	
985			S. L. Small, Dexter	26.00
1039	Great Eastern General Corn Manure	Great Eastern Fertilizer Co.,	Loud & Wilson, E. Newport	34.00
1042			K. Pooler, Stillwater	35.00
1044			H. H. Page, Orono	35.00
1040	Great Eastern General Potato Manure		Loud & Wilson, E. Newport	34.00
1043			H. H. Page, Orono	35.00
862	Great Planet Manure	Clark's Cove Fertilizer Co., New Bedford, Mass.	A. A. Mitchell, Portland	
922			D. Morrill, Bangor	36.00
999	Ground Bone and Potash	E. Frank Coe, New York.,	Geo. E. Bryant, Knox	
856	High Grade Amm. Bone Superphosphate		G. O. Goodwin, Mech'c F'lls	33.00
885			S. H. Fitz, Freeport	
912			Hunter&McMaster Pittsfield	35.00
927			L. K. Cary, Ft. Fairfield	38.00
847	King Phillip Alkaline Guano	Clark's Cove Fertilizer Co.,	Benj. Tucker, Norway	30.00
861			A. A. Mitchell, Portland	
908			W. M. True, Waterville	31.00
923			D. Morrill, Bangor	30.00
954	May Flower Fertilizer	John S. Reese & Co., Baltimore, Md.,	Smith & Van Allen, Houlton	33.00
955	New England Favorite		Smith & Van Allen, Houlton	35.00

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Dealer.	Selling Price.
888	New Rival Amm. Superphosphate	Crocker Fert. & Chem. Co., Buffalo, N. Y.,	Geo. H. True, Freeport	
977	" " " "	" " " " " "	L. A. Knowlton, Belfast	$30.00
1013	Nobsque Guano	Pacific Guano Co., Boston, Mass.,	Carleton Bros., Portland	26.00
984 998 1020	Original Bay State Bone Superphosphate	J. A. Tucker & Co., Boston, Mass.,	E. G. Libbey, Dexter E. Cornforth, Thorndike N. Dayton Bolster, Paris	33.00 33.00 34.00
978 1036	Original Coe's Superphosphate	Bradley Fertilizer Co., Boston, Mass.,	A. A. Howes, Belfast Steward Bros., Skowhegan.	
1005 1018	Otis Superphosphate	S. G. Otis, Hallowell, Me.,	Willis, Kittredge, Cottle & Co. Hallowell Chas. E. Freeman, Norway.	 31.50
953	Pilgrim Fertilizer	John S. Reese & Co., Baltimore,	Smith & Van Allen, Houlton	30.00
926 948	Potato Fertilizer, High Grade	E. Frank Coe, New York,	L. K. Cary, Ft. Fairfield W. G. Brown, Houlton	38.00 35.00
890 929 946	Potato Hop and Tobacco Phosphate	Crocker Fert. and Chem. Co., Buffalo, N Y.,	Geo. H. True, Freeport L. K. Cary, Ft. Fairfield R. J. Smith, Presque Isle	 38.00 36.00
1021	Plymouth Rock Fertilizer	Ames Fertilizer Co., Peabody, Mass.,	J. V. McKinney, Auburn	

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Dealer.	Selling Price.
881	Quinnipiac Phosphate	Quinnipiac Co., Boston,	Carleton Bros., Portland	$36.00
895			Wm. Grant, Randolph	
962			N. S. Kent, Bucksport	37.00
964			L. A. Knowlton, Belfast	35.00
882	Quinnipiac Potato Manure	" " "	Carleton Bros., Portland	36.00
896			D. G. Given, Turner's Cor.	
960			N. S. Kent, Bucksport	37.00
973			L. A. Knowlton, Belfast	36.00
883	Quinnipiac Seeding Down Manure	" " "	Carleton Bros., Portland	32.00
961			N. S. Kent, Bucksport	30.00
967			L. A. Knowlton, Belfast	30.00
956	Reeves' Potato Special Corn Manure	John S. Reese & Co., Baltimore, Md.,	Smith & Van Allen, Houlton	40.00
899	Royal Bone Phosphate	Williams & Clark Co., Boston,	F. W. Chadwick, N. Whitefi'ld	
970			L. A. Knowlton, Belfast	30.00
1025			E. W. Verrill, Auburn	
893	Sagadahoc Superphosphate	Sagadahoc Fertilizer Co.,	Sag. Fert. Co., Bowdoinham	30.00
910			A. R. Smith, Clinton	30.00
939			Geo. A. Tibbetts, Corinna	32.00
871	Soluble Pacific Guano	Pacific Guano Co., Boston,	Carleton Bros., Portland	35.00
904			Robert Pope & Co., Gardiner	35.00
909			W. M. True, Waterville	34.00
945			E. L. Tarbell, Presque Isle	35.00
993	Soluble Pacific Special Potato Manure	" " " "	D. Morrill, Bangor	

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Dealer.	Selling Price.
884	Soluble Pacific Special for Tobacco and Potatoes	Pacific Guano Co., Boston,	Carleton Bros, Portland....	$35.00
972			L. A. Knowlton, Belfast....	38.00
1045	South Carolina Rock (Lowe)....................	Bowker Fertilizer Co., Boston,	College Farm, Orono.......	
891	Special Potato Fertilizer........................	Sagadahoc Fertilizer Co., Bowdoinham,	Sag. Fert. Co., Bowdoinham	34.00
932			A. L. Haines, Ft. Fairfield.	36.00
958			Geo. A. Tibbetts, Corinna..	35.00
1019			C. B. Cunningham & Son, Norway..	26.00
940			E. A. Goodwin, Caribou...	36.00
925	" " "	E. Frank Coe, New York,	L. K. Cary, Ft. Fairfield...	40.00
937			Irving & Ricker, Caribou..	38.00
949			W. G. Brown, Houlton....	35.00
864	Standard A Brand, Seeding Down.............	Standard Fertilizer Co., Boston.............	Carleton Bros., Portland...	30.00
968			L. A. Knowlton, Belfast...	30.00
1000			S. S. Downs, Thorndike....	27.00
850	Standard Fertilizer..............................		C.B.Cummings&SonNorw'y	32.00
865			Carleton Bros., Portland...	32.00
930			Thurlow, Richards & Co., Ft. Fairfield..	38.00
939			S. S. Hackett, Caribou.....	38.00
866	Standard Guano............		Carleton Bros., Portland...	30.00
931			Thurlow, Richards & Co., Ft. Fairfield..	35.00
938			S. S. Hackett, Caribou.....	35.00

DESCRIPTION OF SAMPLES.

Station Number.	Brand.	Manufacturer.	Dealer.	Selling Price.
992	Standard Potato Fertilizer	Standard Fertilizer, Boston, Mass.,	D. Morrill, Bangor	
1012			Carleton Bros., Portland	
969	Standard Superphosphate		L. A. Knowlton, Belfast	$37.00
994			D. Morrill, Bangor	
1011			Carleton Bros., Portland	32.00
1001	Stockbridge Manure for Corn	Bowker Fertilizer Co., Boston,	A. W. Ward, Thorndike	40.00
1006			B. F. Curtis, Richmond	41.00
1030			W. H. Keith, Winthrop	40.00
1062	Stockbridge Manure for Onions		W. M. True, Waterville	42.00
851	Stockbridge Manure for Potatoes		S. P. Wardwell, E. Otisfield	
898			F. R. Benson, Turner's Cor.	
934			A. L. Haines, Ft. Fairfield.	42.00
943			E. E. Parkhurst. Presque I.	42.00
950			Hiram Smith, Houlton	40.00
1002	Stockbridge Manure for Roots		A. W. Ward, Thorndike	40.00
1024	Stockb'ge Man. for Small Fruits and Strawberries		J. P. Merrill, Auburn	42.00
982	Stockbridge Manure for Top Dressing		Co-operative Store, Dexter.	40.00
1032			Wm. True, Waterville	42.00
1007	Stockbridge Manure for Vegetables		B. F. Curtis, Richmond	41.00
1014	Sulphur and Tobacco Lawn Fertilizer	F. C. Sturtevant, Hartford, Conn.,	W. C. Sawyer, Portland	50.00
854	Williams & Clark Potato Phosphate	Williams & Clark Fertilizer Co., Boston,	S. D. Edwards, Oxford	36.00
870			Carleton Bros., Portland	36.00
965			L. A. Knowlton, Belfast	35.00

RESULTS OF ANALYSES.

Station Number.	Brand.	% Moisture	% Nitrogen	Phosphoric Acid. % Soluble	% Reverted	% Insoluble	% Total	% Available	% Potash	Station Valuation. $ Value of nitrogen	$ Value of phosphoric acid	$ Value of potash	$ Total valuation
997	Alkaline Bone	9.45	1.24	6.45	2.53	3.44	12.42	8.98	1.86	3.97	14.59	1.96	20.52
855	Americus Amm. Bone Superphosphate	13.60	2.65	6.26	3.80	1.22	11.28	10.06	1.77	8.48	15.20	1.59	25.27
869	Americus Corn Phosphate	13.45	2.29	7.39	2.71	1.82	11.92	10.10	1.57	7.33	15.60	1.41	24.34
957	Amm. Bone Superphosphate (Standard Grade)	8.90	1.70	5.81	2.50	4.39	12.70	8.31	1.21	5.44	13.97	1.27	20.68
859	Bay State Fertilizer for Seeding Down	15.20	1.25	5.91	2.65	1.84	10.40	8.56	2.28	4.00	13.31	2.05	19.36
990	B. D. Sea Fowl Guano	13.05	2.32	7.25	2.59	1.80	11.64	9.84	1.62	7.42	15.22	1.46	24.10
853	Bowker's Amm. Bone Fertilizer	11.00	2.30	6.77	1.58	4.72	13.07	8.35	2.57	7.36	14.25	2.31	23.92
1027	Bowker's Farm and Garden Phosphate	10.70	2.22	6.72	1.15	4.54	12.41	7.87	2.34	7.10	13.51	2.11	22.72
897	Bowker's Hill and Drill Phosphate	11.95	2.70	7.16	2.78	2.42	12.36	9.94	2.17	8.64	15.60	1.95	26.19
852	" Potato Manure	7.70	2.53	4.04	3.03	7.11	14.78	7.[illegible]7	7.[illegible]4	8.10	18.98	[illegible].48	28.51
951	" " Phosphate	11.95	2.47	6.46	1.47	4.04	11.97	7.[illegible]3	[illegible].48	[illegible].90	18[illegible]	[illegible]	23.50

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RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid. Soluble %	Reverted %	Insoluble %	Total %	Available %	Potash %	Station Valuation. Value of nitrogen $	Value of phosphoric acid $	Value of potash $	Total valuation $
1010	Bowker's Square Brand Bone and Potash	5.60	1.68	2.19	3.78	12.50	18.47	5.97	2.14	5.38	13.57	1.93	20.88
1004	" Sure Crop Bone Phosphate	13.25	1.02	8.80	1.50	2.85	13.15	10.30	1.48	3.26	16.44	1.33	21.03
947	Bradley's Complete Manure for Potatoes and Vegetables	11.10	3.55	6.84	2.15	1.94	10.93	8.99	6.30	11.72	14.04	5.67	31.43
873	" Eureka Seeding Down Fertilizer	9.10	2.30	3.12	2.25	6.55	11.92	5.37	2.26	7.36	10.45	2.03	19.84
857	" Potato Manure	12.55	2.75	3.95	2.02	2.56	8.53	5.97	5.04	8.80	9.77	4.54	23.11
858	Bradley's X. L. Superphosphate	12.10	2.79	7.04	2.78	2.29	12.11	9.82	2.14	8.93	15.37	1.93	26.23
863	Clark's Cove Bay State Fertilizer	13.70	2.54	6.58	3.19	1.48	11.25	9.77	1.92	8.13	14.93	1.73	24.79
848	" " " " G. G	13.25	2.34	7.04	2.99	1.79	11.82	10.03	2.10	7.49	15.47	1.89	24.85
879	Cleveland Potato Phosphate	13.18	2.27	7.23	2.11	1.96	11.30	9.34	2.91	7.26	14.57	2.62	24.45
878	Cleveland Seeding Down Fertilizer	10.65	1.82	4.39	2.15	4.59	11.13	6.54	2.10	5.82	11.43	1.89	19.14
880	Cleveland Superphosphate	13.20	2.28	6.82	2.48	2.35	11.65	9.30	2.26	7.30	14.64	2.03	23.97

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid. Soluble %	Phosphoric Acid. Reverted %	Phosphoric Acid. Insoluble %	Phosphoric Acid. Total %	Phosphoric Acid. Available %	Potash %	Station Valuation. Value of nitrogen $	Station Valuation. Value of phosphoric acid $	Station Valuation. Value of potash $	Station Valuation. Total valuation $
889	Crocker's Corn Phosphate	11.45	2.21	7.04	2.22	2.47	11.73	9.26	1.75	7.07	14.66	1.57	23.30
1046	Concentrated Phosphate	5.20			32.93	12.55	45.48	32.93			51.12		51.12
849	Cumberland Superphosphate	12.55	2.48	6.60	2.71	2.19	11.50	9.31	2.19	7.94	14.57	1.97	24.48
917	" Potato Fertilizer	12.85	2.18	6.82	2.87	1.27	10.96	9.69	2.45	6.98	14.76	2.20	23.94
877	" Seeding Down Fertilizer	14.65	1.76	4.14	2.05	2.56	8.75	6.19	.95	5.63	10.10	.85	16.58
892	Dirigo Fertilizer	6.82	3.04	.63	.65	5.33	6.61	1.28	4.10	9.73	3.98	3.77	17.48
918	Farrar's Potato Fertilizer	12.85	2.75	7.06	2.47	1.77	11.30	9.53	4.44	8.80	15.69	3.99	28.48
919	Farrar's Superphosphate	13.30	2.57	6.93	2.22	2.37	11.52	9.15	2.06	8.22	14.45	1.85	24.52
887	Grass and Grain Fertilizer	10.75	.63	5.33	3.90	3.93	13.16	9.23	1.25	2.03	15.02	1.10	18.23
1039	Great Eastern General Corn Manure	14.82	3.01	3.61	5.61	.91	10.13	9.22	2.26	9.63	13.62	2.03	25.28
1040	" " " Potato Manure	14.30	2.45	3.68	5.84	.93	10.45	9.52	3.87	7.84	14.07	3.48	25.39

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture	Nitrogen	Phosphoric Acid.					Potash	Station Valuation.			
				Soluble	Reverted	Insoluble	Total	Available		Value of nitrogen	Value of phosphoric acid	Value of potash	Total valuation
		%	%	%	%	%	%	%	%	$	$	$	$
862	Great Planet Manure	11.00	3.45	6.65	2.03	1.48	10.16	8.68	6.78	11.40	13.40	5.42	30.22
999	Ground Bone and Potash	6.40	1.40		2.13	9.72	11.85	2.13	3.35	4.48	6.87	3.01	14.36
856	High Grade Amm. Bone Superphosphate	8.40	2.12	7.50	2.20	2.11	11.81	9.70	2.10	6.96	15.17	2.12	24.25
847	King Phillip Alkaline Guano	14.15	1.70	5.58	2.59	2.42	10.59	8.17	2.90	5.44	12.95	2.61	21.00
954	Mayflower Fertilizer	15.62	1.63	2.78	7.57	.90	11.25	10.35	1.59	5.22	15.12	1.43	21.77
955	New England Favorite	14.47	1.86	3.44	6.78	1.27	11.49	10.22	1.14	5.95	15.16	1.03	22.14
888	New Rival Amm. Superphosphate	12.70	1.31	5.96	2.64	3.22	11.82	8.60	1.55	4.19	13.91	1.39	19.49
1013	Nobsque Guano	13.90	1.29	6.33	2.25	1.65	10.23	8.58	2.47	4.13	13.30	2.22	19.65
984	Original Bay State Bone Superphosphate	11.27	2.87	2.05	5.41	3.66	11.12	7.46	4.07	9.18	12.10	4.21	25.49
978	Original Coe's Superphosphate	13.22	2.29	6.97	2.15	3.03	12.15	9.12	1.61	7.83	14.07	1.45	23.45
1005	Otis Superphosphate	13.35	2.87	6.84	2.90	2.30	12.04	9.74	2.31	9.18	15.24	2.08	26.50

RESULTS OF ANALYSES.

Station Number.	Brand.	% Moisture	% Nitrogen	Phosphoric Acid. % Soluble	% Reverted	% Insoluble	% Total	% Available	% Potash	Station Valuation. $ Value of nitrogen	$ Value of phosphoric acid	$ Value of potash	$ Total valuation
953	Pilgrim Fertilizer	15.36	1.16	2.17	6.51	1.23	9.91	8.66	1.70	3.71	12.58	1.58	18.09
926	Potato Fertilizer, High Grade	10.10	2.26	5.54	2.00	2.05	9.59	7.54	5.13	7.23	11.93	5.39	24.55
890	Potato, Hop and Tobacco Phosphate	12.30	2.11	6.38	2.61	1.96	10.95	8.99	2.87	6.75	14.00	2.58	23.28
1021	Plymouth Rock Fertilizer	11.75	2.93	5.03	5.43	.70	11.16	10.46	3.52	9.36	15.42	3.57	28.37
881	Quinnipiac Phosphate	14.00	2.74	6.84	3.01	1.50	11.35	9.85	1.73	8.77	15.08	1.56	25.41
882	" Potato Manure	11.95	2.69	4.52	1.58	2.14	8.24	6.10	5.34	8.61	9.85	4.81	23.27
883	" Seeding Down Manure	14.50	1.20	6.41	2.10	1.84	10.35	8.51	2.12	3.84	13.29	1.91	19.04
956	Reeves' Potato Special Concentrated Manure	14.85	2.97	2.72	5.02	.55	8.29	7.74	8.45	9.50	11.05	7.60	28.15
899	Royal Bone Phosphate	15.00	1.26	5.87	2.15	2.16	10.18	8.02	2.26	4.03	12.67	2.03	18.73
893	Sagadahoc Superphosphate	12.50	2.81	6.92	2.10	1.19	10.21	9.02	3.00	8.99	13.80	2.70	25.49
871	Soluble Pacific Guano	14.50	2.36	6.83	3.43	.84	11.10	10.26	2.03	7.55	15.38	1.83	24.76

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid. Soluble %	Phosphoric Acid. Reverted %	Phosphoric Acid. Insoluble %	Phosphoric Acid. Total %	Phosphoric Acid. Available %	Potash %	Station Valuation. Value of nitrogen $	Station Valuation. Value of phosphoric acid $	Station Valuation. Value of potash $	Station Valuation. Total valuation $
993	Soluble Pacific Special Potato Manure..................	13.40	2.87	4.11	1.59	1.96	7.96	6.00	5.06	9.18	9.62	4.55	23.35
884	" " " for Tobacco and Potatoes.......	12. 0	2.25	7.25	2.22	1.78	11.25	9.47	3.13	7.25	14.69	2.82	24.71
1045	South Carolina Rock..................................	1.00			1.52	23.82	25.34	1.52			11.66		11.66
89	Special Potato Fertilizer, Sagadahoc..................	11.50	2.84	5.17	1.81	1.00	7.98	6.98	7.86	9.28	10.68	7.36	27.32
925	Special Potato Fertilizer (Coe's).......................	8.80	1.78	7.01	2.09	2.21	11.31	9.10	3.46	5.70	14.32	3.66	23.68
864	Standard A Brand Seeding Down.........................	10.60	1.29	6.61	2.68	2.23	10.08	7.85	1.49	4.13	12.39	1.34	17.86
850	Standard Fertilizer....................................	13.90	2.34	5.17	2.93	2.11	11.05	9.54	2.07	7.48	14.85	1.86	24.19
808	" Guano..	15.10	1.33	4.76	2.64	2.26	9.66	7.40	2.82	4.23	11.74	2.09	18.09
992	" Potato Fertilizer................................	13.55	2.14	7.32	2.30	1.48	11.10	9.62	2.62	6.85	14.79	2.36	24.00
969	" Superphosphate...................................	13.70	2.65	6.54	3.19	1.71	11.44	9.73	2.07	8.48	14.95	1.86	25.29
1001	Stockbridge Manure for Corn...........................	10.77	2.94	6.64	2.94	3.43	13.01	9.58	4.46	9.41	15.43	4.01	28.85

RESULTS OF ANALYSES.

Station Number.	Brand.	Moisture %	Nitrogen %	Phosphoric Acid. Soluble %	Phosphoric Acid. Reverted %	Phosphoric Acid. Insoluble %	Phosphoric Acid. Total %	Phosphoric Acid. Available %	Potash %	Station Valuation. Value of nitrogen $	Station Valuation. Value of phosphoric acid $	Station Valuation. Value of potash $	Station Valuation. Total valuation $
1032	Stockbridge Mannre for Onions	10.50	3.50	5.88	2.50	2.62	11.00	8.38	5.89	11.20	13.87	5.90	29.87
851	" " " Potatoes	9.02	3.46	6.35	2.55	2.33	11.23	8.90	6.06	11.07	14.02	5.45	30.54
1002	" " " Roots	4.80	5.06	1.97	2.23	7.38	11.58	4.20	7.12	16.19	9.02	6.40	31.61
1024	" " " Small Fruits and Strawberries.	8.25	2.51	6.14	2.24	3.59	11.97	8.38	9.30	8.03	13.79	10.22	32.04
982	" " " Top Dressing	4.45	4.99	1.28	3.66	7.48	12.42	4.94	5.93	15.97	10.03	5.85	31.85
1007	" " " Vegetables	10.15	3.70	5.01	3.09	2.56	10.66	8.10	6.69	11.84	12.85	6.01	30.70
1014	Sulphur and Tobacco Lawn Fertilizer	13.50	2.12			.88	.88		7.05	6.78	.33	7.75	14.86
854	Williams & Clark Potato Phosphate	12.07	2.85	4.35	1.73	2.38	2.38	7.17	5.43	9.12	9.89	4.89	23.09

OBSERVATIONS ON THE FERTILIZER INSPECTION OF 1892, AND REMARKS ON METHODS OF BUYING PLANT FOOD.

In the case of sixty-four brands of fertilizers analyzed, the average selling price as given to the Station Agent was $34.08. The average station valuation of the same brands was $24.07, or $10 less than the selling price.

The station valuation is the same for which the fertilizing ingredients in one ton can be bought in the large markets in a condition ready for use, consequently in 1892 it is costing the farmer $10 per ton or forty per cent. of the retail price in Boston, for instance, to have the goods placed at his door. Perhaps it may be said that some manufacturers are furnishing plant food more cheaply. In the case of seventeen brands sold by two leading manufacturers, the average selling price is $36.38 and the average station valuation $27.05, a difference of $9.33, or 34.5 per cent. of the cost in the market.

It appears then, that even with the manufacturers most largely patronized, there is a margin of over $9.00 between what farmers are actually paying for a ton of superphosphate and the cost of the same amount of plant food in unmixed goods when bought in the large markets. It certainly does not cost $9.00 for freight and mixing. The other items of expense are agents' commissions, credit, etc., and these might be saved by a change in business methods.

This subject has been extensively studied and discussed by the New Jersey Experiment Station, and the following admirable comments by Mr. Voorhees, chemist of the station, are of interest to farmers in general.

"The principal points which have been shown are—1. That the nitrogen, phosphoric acid and potash in raw or unmixed materials can be bought at a less cost per pound than the Station's valuations; and 2. That the cost of the same elements in mixed fertilizers is at least 25 per cent. greater than Station's valuations. The difference between these two methods of buying would amount on the basis of last year's sales to over $336,000. (For New Jersey.) This sum is consumed not in manufacturers' profits alone, as some suppose, but in the transportation of a vast amount of absolutely worthless material, in agents' commissions and in credit.

There are two classes of farmers who claim that it does not pay to buy the unmixed or incomplete materials: First, those who use very small quantities; and, second, those who act as selling and advertising agents. In the first case less favorable terms are quoted for unmixed materials, and the expenses of freight and handling are proportionately increased, thus adding materially to the cost of actual fertilizing elements. In the second case specific brands are bought direct from the manufacturer in large lots at low rates for cash, thus saving in freight, commission and credit upon personal supplies. The majority of farmers, however, especially those who make farming their sole business, do not belong to either of these classes, and hence these arguments lose their force, though not their influence, on such farmers as are not progressive and do not study closely the matter of economical buying. Still, if manufacturers would treat all buyers as they do their agents and sell to them direct, and farmers could be made to realize the importance of co-operation and of cash purchases, the trade in complete fertilizers would be more satifactory to both producer and consumer. Under present conditions, however, the evidence gathered by the Station is manifestly in favor of the buying of unmixed materials and applying direct, as needed, or mixing to suit the varied needs of crop and soil."

Among the causes which should receive emphatic mention as producing the high prices for mixed fertilizers sold by agents, is the credit system, and for this the farmer is himself largely responsible. A cash system would make a saving of so large a per cent. of the cost of fertilizers as to render it profitable for farmers to hire money at six per cent. in order to pay down for their goods. Still further advantage would be secured by co-operation in the buying of large quantities.

Unmixed fertilizers such as plain superphosphates, nitrate of soda and muriate of potash have been mentioned as furnishing plant food more cheaply than the mixed goods, but this is not necessarily the case. It so happens that the former materials are the ones which can be purchased without the intervention of the travelling and local agents, whose interests must be protected by the manufacturer, and these are the goods to which the more economical method of buying can more easily be applied. As Mr. Voorhees suggests, the common brands of superphosphate could doubtless be obtained on just as favorable terms, provided a change could be made to direct sales of large quantities for cash.

If farmers would give this matter immediate practical attention, they would be more certain to secure prompt and important financial advantages than by the long drawn out discussions over tax and tariff reforms, however important these may be.

The disadvantages of the present method by which our farmers are largely obtaining their fertilizers may be summarized as follows:

(1) It is a costly system of selling due to the large expense for agents and the great loss on credits.

(2) It is a system which unfortunately seems to be accompanied by so many unfair arguments and so much of distortion of facts that the farmer is, to some extent, hindered rather than aided in gaining clear ideas of true facts.

(3) And so this is a system which leads farmers to consider chiefly the rival claims of competing manufacturers rather than to study his own needs and then to buy such plant food as is adapted to his wants.

If farmers are to purchase commercial plant food, great advantages would result in a change to the following system:

(1) The buying of plant food as such under proper names, and thus avoid the confusion and uncertainty attending the purchase of an ever increasing number of brands whose names mean little or nothing.

(2) The purchase of fertilizers in large quantities for cash.

MISCELLANEOUS ANALYSES.

835. *Muck* from I. O. Winslow, St. Albans.

841 and 842. *Mucks* from E. E. Light, Burkettsville.

	835		841		842	
	Original condition.	Water-free.	Original condition.	Water-free.	Original condition.	Water-free.
Water	77.52	——	80.66	——	79.54	——
Ash and Sand	4.30	19.15	1.49	7.70	7.04	34.43
Potash	.03	.14	.02	.08	.04	.20
Phosphoric Acid	.24	1.08	.10	.54	.19	.96
Nitrogen	.38	1.70	.42	2.16	.34	1.67

When received at the station samples of muck contained so much water that it is necessary to dry them before they can be properly pulverized for analysis. The results obtained are recalculated for the original content of water and also, for purposes of comparison, to a water-free basis. The first figures are, of course, of most interest to the farmer, as they represent more nearly the condition of the muck as it is ordinarily used for agricultural purposes.

672. *Feldspar.*—From Cumberland Bone Co. Potash 12.07 per cent. A typical orthoclase feldspar may contain as high as 16.9 per cent. potash. Here, as in most feldspars of the orthoclase variety, a part of the potash is replaced by soda.

676. *Fish Pomace.*—From P. B. Friend, N. Sedgwick. This is said to consist for the most part of the heads of herrings, from a sardine factory. It contains: Water 54.66 per cent., Nitrogen 5.26 per cent., Potash .26 per cent., Phosphoric acid 2.05 per cent.

684. *Sea Weed.*—From H. A. Long, Gt. Beach, Roque Island. Water 76.00 per cent., Nitrogen 1.04 per cent., Phosphoric acid .07 per cent.

834. *Cedar Ashes.*—From Judge Robinson, Houlton. Water 1.52 per cent., Potash 5.09 per cent., Phosphoric acid 1.91 per cent.

843. *Ashes from Burned Muck.*—From Albert Pease, Phillips. This material is largely siliceous, about 95 per cent. being insoluble in hydrochloric acid. It contains traces of phosphoric acid, but not enough to give it any value.

ANALYSES OF CATTLE FOODS.

Certain cattle foods have been sent to the Station for analysis from time to time, the composition of some of which is given below.

CXXXVI. Linseed Meal, sent by Hon. Z. A. Gilbert.

CXXXVII. Feed Flour, " " " " "

CXXXVIII. Flour Sweepings, sent by E. F. Roundy, North Hermon.

CXXXIX. Flour Sweepings, sent by E. F. Roundy, North Hermon.

CXXIII. Pratt's Food, sent by A. C. Chandler, New Gloucester.

Station Number.		Air dry.						Water-free.				
		Moisture.	Ash.	Protein N x 6.25.	Fiber.	Nitrogen free extract.	Fats.	Ash.	Protein N x 6.25.	Fiber.	Nitrogen free extract.	Fats.
CXXXVI	Linseed Meal...	9.03	5.60	39.94	7.28	35.27	2.88	6.15	43.94	8.00	38.77	3.15
CXXXVII	Feed Flour......	7.32	2.82	20.81	1.93	62.44	4.68	3.04	22.44	2 08	67.38	5.05
CXXXVIII	Flour Sweepings	11.33	2.50	10.62	1.89	72.03	1.63	2.82	11.98	2.13	81.23	1.84
CXXXVIX	" "	8.80	15.95	9.19	1.50	59.35	5.21	17.49	10.07	1.64	65.09	5.71
CXXIII	Pratt's Food	12.36	5.79	13.75	5 94	56.80	5.36	6.60	15.69	6.77	64.83	6.11

The above analyses of cattle foods call for no special comment with the exception of Pratt's Food for horses and cattle. There are several weighty reasons why this food should receive careful consideration.

(1) It is sold at the rate of $120 per ton.

(2) Its manufacturers claim that it prevents nearly all of the common diseases and disorderes to which farm animals are subject, that it is, besides, a preventive of certain serious contagious diseases, that it produces richer milk and more of it, that animals fatten quickly when it is fed, and that it gives to horses greater power of endurance.

If the manufacturers of this material have succeeded in combining a food that in its relation to disease has such a high preventive and remedial influence, and in its relation to the nutrition of an animal produces the highly valuable results which appear to be claimed by their circulars, they should be classed among the benefactors of the age. It must be confessed, however, that the advertised claims of this food exceed the credible and pass into the absurd.

This becomes all the more evident when we consider what the food is. It has received a careful examination at this Station, and while we are not prepared to say that it does not contain minute quantities of substances which we have not discovered, we have become convinced that its composition does not warrant its purchase at any unusual price. The results of our examination are as follows:

(1) The food has the appearance of being chiefly ground bran or shorts and is undoubtedly what it appears to be.

(2) The food contains a small amount of fenugreek, an aromatic seed supposed to have mild medicinal properties.

(3) It contains something less than three per cent. of common salt.

(4) The quantities of any other substances which it may contain are so small as to not be easily discovered. It is the opinion of those examining the food that no other compounds exists in it save those which are the proper constituents of any food.

(5) The analysis of the food gives about the same figures that we should expect from bran or shorts, with a somewhat smaller percentage of protein than these milling products now contain.

Even if it were found that this food is so compounded as to have, under certain circumstances, a positive medicinal effect, this fact would not constitute a good reason why farmers should purchase and feed it indiscriminately. We no longer believe in quack nostrums that will cure all troubles. The course which the intelligent farmer takes to-day in the treatment of diseased animals is to secure the attendance and advice of a competent veterinarian who will administer remedies suitable to the case in hand. As for the prevention of disease it is a common experience that all that is ordinarily necessary is cleanliness, good care and proper and sufficient food. If these conditions do not prevail it is useless for the farmer to attempt to remedy the faults in his management by the use of any advertised cure-all, such as the one under consideration. This food may not possess any injurious properties because of the small amount of unusual constituents which it contains, but in the opinion of the writer its purchase at a price exceeding the ordinary cost of commercial cattle foods is a waste of money.

PRELIMINARY NOTES ON THE SECONDARAY EFFECTS OF POLLINATION.

By W. M. Munson.

The change produced by contact of embryo sac and pollen tube is not confined to the mere vivification of one or more cells; though this is the chief end,—the primary object of all pollination. There are certain secondary effects which are of interest to the botanist and may be of great practical value to the horticulturist.

When there is a difference between male and female parents, the embryo partakes to a greater or less extent of the nature of both parents. In general, this influence is apparent first in the offspring of the cross; but in some instances there appears to be an immediate effect on the ovary or other portions of the female parent. In some cases also, the pollen seems to have a direct stimulating influence on the ovarium, without effecting the impregnation of the ovules. Again, in certain instances the vigor of the plant seems sufficient to develop a marked growth of the ovary in the entire absence of the male element. The form and size of the ovary are often materially affected by the application of different amounts of pollen to the stigma. In some plants more than one embryo is developed in a single ovule, indicating the possibility of superfœtation. These, and other secondary problems arising in connection with the systematic amelioration of cultivated plants, are often of great practical importance.

The following notes can be regarded only as preliminary; as forming a basis from which to start in future work in this direction. Although some of the problems considered have been under discussion for more than a century, they are still unsolved. There has not been sufficient systematic study to warrant the formulation of general laws, and this study must necessarily extend over a long series of years. In the notes are embodied as concisely as may be, the more important results obtained by leading experimenters in this country and in Europe, together with some observations of the writer on the subjects in question.

Special acknowledgement is due to Professor L. H. Bailey of Cornell University, for the use of certain notes and photographs, and for free access to his private library.

I. ON THE IMMEDIATE INFLUENCE OF POLLEN ON THE MOTHER PLANT.

Even before the sexual theory regarding plant reproduction was commonly accepted, the question of the immediate effect of pollen on the form and character of the female parent received the attention of careful observers. Bradley early gave directions for performing the operation of crossing and wrote: "By this knowledge we may altar the property and taste of any fruit by impregnating the one with the farina of another of the same class; as, for example, a Codlin with a Pearmain, which will occasion the Codlin so impregnated to last a longer time than usual and be of a sharper taste; if winter fruit be fecundated with dust of the summer kinds, they will decay before their usual time."[*]

In 1745 Benjamin Cook, in a paper before the Royal Philosophical Society,[†] cited the appearance of russet apples on trees ordinarily producing smooth fruit, and the reverse, as examples of the effect of pollen. Other cases have been frequently noted as proofs of the existence of the same phenomenon.[‡] Even at this early date, however, careful experiments undertaken by Thomas Andrew Knight and others, tended to show that the apparent effects might be due to bud variations, or other causes aside from the action of pollen. Knight at this time wrote: "I have in some hundred instances introduced the pollen of one variety of the plum, the pear, the apple, the cherry, the peach, the melon and other fruits into the blossoms of very different and opposite habits, and I have never, (although I have most closely attended to the results) found in any one instance the form, colour, size or flavour of the fruit belonging to such blossoms in any degree whatever changed or affected."[§]

In 1865 Thomas Meehan opened discussion of the subject in the columns of the Gardener's Monthly, remarking: "For ourselves, without being satisfied that there is any material change in the quality of the fruit, we cannot deny there is some; and there may be much more than we at present imagine. At any rate, we think it may be taken for granted that melons grown near squashes often have a suspicious squashy flavour, that gives some ground for the popular theory of mixing."[‖] The suggestion is further made that if the change be found to occur in squashes, the same law will apply to the whole region of fruit—an assumption which is altogether too broad.

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[*] Bradley, New Improvements in Planting and Gardening, 7th ed. (1739), p. 18.

[†] Philosophical Trans. 1745.

[‡] Trans. Lond. Hort. Soc., V, 65.

[§] Trans. London Hort. Soc., V, 67.

[‖] Gard. Month, VII, 305.

There is evidence which goes to show that within certain limits there is an immediate effect of the male element, but that those limits are quite restricted. As early as 1729 the presence of both white and blue peas in the same pod was observed, when two varieties of the different colors were planted near each other.* This fact has been repeatedly confirmed. In 1822 examples were presented to the London Horticultural Society. A variety known as Blue Prussian was crossed with a white variety. The resultant peas were yellowish-white like the male parent.† Laxton, in 1866, crossed the Tall Sugar Pea which bears thin green pods, with pollen of a purple-podded variety. "The pod resulting was clouded with purple, while one of the peas was of a clear violet-purple tint and another was irregularly clouded with purple." The results, in so far as the changed color of the peas is concerned, were confirmed by Darwin.‡

Crucknell§ cites an instance of apparent immediate influence in case of the pear. A single branch on a Belle Lucrative tree bore a few specimens resembling Vicar or Winkfield. As Vicars were growing near, the conclusion is drawn that the fruits in question were affected by the foreign pollen. There is no reason to suppose, however, that this and the numerous cases of the appearance of russet apples on trees not usually russeted, are other than instances of bud variation, as pointed out by Knight.‖

Of about one hundred artificial pollinations performed by Charles W. Garfield at the Michigan Agricultural College, but three of the crosses showed any variation which could in any way be construed as the effect of pollen. "These were: *First.* Wagener upon Tallman Sweet. There was a modification of flavor quite noticable, the fruit being sub-acid. *Second.* Tallman Sweet upon Astrachan. In this instance there was a manifest change in the color, flavor and shape. The apples were quite mild to the taste, the color was very much modified, and the form was that of a flat apple. *Third.* Tallman Sweet upon Wagener. The modification here was noticable in all the specimens, in flavor and color."* I am informed, however, that at the present time Mr. Garfield doubts the influence of pollen in causing the variations here noted.

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* Philosophical Trans., XLIII, 525.

† Trans. Hort. Soc., V, 234.

‡ An. and Plts. Under Domest., I, 428.

§ Gard. Month., IX, 165.

‖ Trans. London Hort. Soc., V, 67.

Professor L. H. Bailey in 1887, performed many crosses with different varieties of apples "and got no effect in any way, not even in season of maturity or in texture."† Similar results were obtained by Crozier in 1888. More than one thousand crosses were made, and they were carefully observed during the season with a view to detecting any immediate effects. "The examination failed to show any differences which could be attributed to the influence of the cross. In several instances different varieties were crossed upon the same tree, but the resulting fruits did not differ materially from each other, or from the remainder of the crop upon the tree."‡

In many species, both wild and cultivated, sports bearing fruit differing from the normal type, are not uncommon. Diœcious plants of this character must necessarily receive pollen from an individual of a different character, but as a rule no effect is observed on the appearance of the fruit of either individual. A single plant of *Mitchella repens*, bearing white berries, was discovered by Mr. Meehan and removed to his grounds. Thus isolated, it produced no fruit, but in the natural state, and fertilized by pollen from the red-berried form, the white fruit was produced in abundance. *Ilex verticillata* as a rule has red berries, but a white-berried form on the grounds of Professor Sargent regularly produced white fruit, although necessarily receiving pollen from the red form.§

On the other hand, instances are cited to show that there is a marked effect on the color of flowers when two varieties of different color are in close proximity. White verbenas, growing by the side of a pink variety are said to have produced striped flowers on the side of the plant next to the pink variety—the other side of the plant retaining the white color.‖ Similar instances of changed color in case of phlox and petunias have come under my own observation, but in each of these cases the plants were so situated that the change could not be construed as due to the influence of pollen.

If pollen exerts a modifying influence on the character of the fruit, we should expect the color of black grapes to be less intense if fertilized by pollen from white varieties, than if self-fertilized, or crossed by other dark varieties. That such influence is doubtful, however, is indicated by the work of Goff, of Crozier and others.

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* Gard. Month., XVIII, 23, (Jan., 1876.)
† Proc. Am. Pom. Soc., 1887, 22.
‡ Crozier, Bul. 3, Iowa Agr. Expt. Sta., 92.
§ Gard. Month., XXVII, 116.
‖ Berckmans, Am. Agriculturist, July, 1889, 344.

In 1886, Goff crossed several varieties of black grapes with pollen from a white variety—the Lady Washington. Other flowers on the same vines were self fertilized. At maturity it was impossible to detect any difference either of color or of flavor between the self-fertilized and the crossed berries of the same variety.[*] Similar results were obtained by Crozier at the Iowa Experiment Station in 1888.[†]

The cotton plant furnishes an instance in which there is apparently unmistakable evidence of the immediate effect of foreign pollen. In 1890, at the Georgia Experiment Station, flowers of upland cotton, *Gossypium Barbadense*, were crossed with pollen from common Okra, *Hibiscus esculentus*. Apparently perfect bolls of cotton were formed, but in every instance the seed failed to germinate when planted. The reciprocal cross resulted in apparently normal Okra seeds, but the offspring varied from the normal in time of flowering and fruiting.[‡] In 1891 the work was repeated, and Director R. J. Redding in a private letter to the writer reports, "bolls of cotton, the result of cotton blooms pollenized with Okra pollen this year, in which one and sometimes two of the carpels contained a very small quantity of lint adhering to the seed while the other divisions of the ovary were abortive."

It was early observed[§] that there is an immediate visible effect of foreign pollen on corn, extending in many cases even to the receptacle, and the repeated confirmations by Crozier, Sturtevant,[||] Kellerman,[¶] Tracy[**] and others would leave little doubt as to the accuracy of the observations.

That there is a difference in varieties, in the readiness with which the influence of pollen is shown, is altogether probable. Sturtevant lays down the general proposition: "Under the conditions of ordinary seed, maize does not in general show the effects of current cross-fertilization, the exception being the sweet corns which exhibit the influence of current foreign pollen very readily."[††] The proposition is based on the study of about one hundred and twenty-five named varieties, including flint, dent, pop, and sweet corns. That the flint and dent varieties often exhibit a change the current year, however, is abundantly proved by the work of the other experimenters referred to; though all agree that the change is most readily seen in sweet corn, and least so in the flint varieties. In this connection, also, Sturtevant makes the statement that "cross-bred corn has a greater tendency to current cross-fertilization than has purely bred corn"*—a condition we should naturally expect from the variable tendency of hybrids and cross-breeds. While there would seem to be no doubt as to the immediate influence of foreign pollen in the case of corn, it is not improbable that what is in reality seminal effect, may sometimes be credited to the immediate action of the foreign pollen.

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[*] 5th Rep. N. Y. Agr. Exp. Sta., 180.
[†] Agr. Sci., II, 319.
[‡] Expt. Sta. Record, III, 135.
[§] Philosophical Trans., XLVII, 206.
[||] 3rd Rep. N. Y. Exp. Sta., 148.
[¶] 2nd Rep. Kan. Exp. Sta., 288-335, (1889).
[**] Rep. Mich. Hort. Soc., 1888, 43.
[††] 3d Rep. N. Y. Ag. Exp. Sta., 149.

Darwin cites numerous instances† to prove the existence of an immediate effect of crossing and though some of the examples to which he gave credence are now discredited, many of them are apparently well authenticated.

Seeds of *Matthiola annua* are normally of a light brown color, while those of *M. incana* are violet black; yet *M. annua* crossed by *M. incana* yielded about fifty per cent. of black seeds. Flowers of the orange fertilized by pollen from a lemon tree produced fruit bearing a longitudinal stripe of peel having the color, flavor and other characters of the lemon. Recent observations in this country and in Europe would appear to confirm the statements regarding citrus fruits.‡ Sabine§ cites an instance in which the form of the ovary of *Amaryllis vittata* was altered by the application of foreign pollen; while Maximowicz made reciprocal crosses between *Lilium bulbiferum* and *L. davuricum* and found "each species produced fruit almost identical with the pollen bearing species."‖ Fritz Müller crossed *Cattleya Leopoldi* by *Epidendron cinnabarianum*, and obtained a marked change in the form of the seeds.¶

Rhododendron dalhousiæ crossed by *Rhododendron Nutallii* is cited by Darwin as an example of the increased size of ovary resulting from the action of foreign pollen, while *Arabis blepharophylla* crossed by *A. Soyeri* produced pods larger than either parent species.** Darwin also gives credence to the story of the St.

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* 3rd Rep. N. Y. Ag. Exp. Sta., 149.
† An. and Plts. Under Domest., I, 428 et seq.
‡ See Repts. Am. Pom. Soc., 1889 and 1891.
§ Trans. Lond. Hort. Soc., V, 69.
‖ Darwin, An. and Plts. Under Domest., I, 431.
¶ Ibid.
** Ibid, 432.

Valery apple, the stamens of which are abortive, and being artifically pollinated, the fruits are said to differ from one another in size, flavor and color, resembling in character the various kinds by which they have been fertilized.*

In the cultivation of pistillate varieties of strawberries, it is usually considered necessary to set some variety with well developed stamens in the immediate vicinity to furnish the pollen requisite to the fertilization of seeds, and consequent development of the receptacle. It is believed by many growers that the character of these pistillate varieties may be varied at will, by using different varieties for the male parent. In other words, it is believed that there is an immediate effect of the male element in determining the time of maturity, the color, the shape, and even the flavor of the receptacle of the variety crossed. If this theory be based on fact, it is of no small practical importance. If it were true, that in all cases, or that as a rule, the fruit partakes of the character of the male parent, there could be no fixed character to any pistillate variety. But will the facts warrant the assumption that this immediate effect in the case of strawberries is by any means universal, if common? Personally I have conducted no work bearing upon this point, but several experiments have been performed by careful observers, and the results obtained by them are of interest in this connection. The results as published differ considerably, but in general, the weight of authority goes to show that the receptacle is not materially affected by the male element.

At the meeting of the American Pomological Society in 1885, extended and spirited discussions of this subject were held. Professor W. R. Lazenby of the Ohio Experiment Station, had found the influence of the male element decidedly manifest. When blossoms of Crescent were fertilized by pollen from Downing, Vick, or Sharpless, the characteristic shape, texture and other qualities of the male used, were impressed on the receptacle to such an extent that it was possible to determine the male parent from the general appearance of the crop.† A repetition of these experiments the following season, however, failed to give any marked results.‡

A. S. Fuller who has made a careful study of the subject since 1859, claims to have obtained very marked indications of an immediate directing influence on the form and size of the receptacle.[*] Mr. Fuller attributes this apparent influence to the direct action of the pollen in stimulating the growth of ovary or receptacle without reference to the fertilization of the ovules. Admitting the stimulating effect, however—and of this there seems to be but little doubt—does the directing effect necessarily follow?

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* Darwin, An. and Plts. Under Domest I, 432.
† Proc. Am. Pom. Soc., 1885, 66.
‡ Rep. Ohio Exp. Sta., 1885, 107.

From an extensive field experiment conducted by Professor T. J. Burrill in 1884, it was found "easy enough to select individual berries conspicuously different from each other, as is always the case, but it was not possible to detect the slightest tendency towards a resemblance to the pollen bearer."[†] In a similar experiment conducted the following year on the farm of P. M. Angur of Connecticut, like results were obtained.[‡]

In none of the carefully conducted experiments of Goff and Hunn at the New York Experiment Station, have any immediate effects been discerned. Berries from Crescent blossoms, receiving the pollen of Lennig's White, were not different in color from those fertilized with Wilson or Sharpless pollen. Flowers fertilized on one side by pollen from the white variety, and on the other with Sharpless pollen were symmetrical in form and uniform in color.[§] Out of one hundred and sixty-seven successful crosses made by Crozier, there was not an individual instance that pointed to a specific influence of the foreign pollen.[||]

The nature of cucurbitaceous plants is admirably adapted to show the immediate effects of crossing if such occur. In a mixed plantation many of the flowers on any individual plant, when left to natural processes, would necessarily receive pollen from very different sources. If now, there were an immediate effect of pollen, we should expect to find fruits of very different character on any vine. Such is not the case, however. I have repeatedly looked for this difference, but have never seen it; nor have I observed it when several flowers on the same plant were artificially crossed with pollen from different varieties or species. Crozier[¶] and Bailey have repeatedly obtained like results. Bailey, whose crosses of cucurbits run up into the thousands, asserts positively that: "There is no immediate influence whatever, except such as is due to imperfect development caused by insufficient or impotent pollen."*

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[*] Proc. Am. Pom. Soc., 1885, 68.

[†] Proc. Am. Pom. Soc., 1885, 67.

[‡] Ibid, 70.

[§] 4th Rep. N. Y. Agr. Exp. Sta., (1885), 227; 5th Rep. (1886), 179; also Bul. 24, (N. S.), 330, (1890).

[||] Agr. Sci., IV, 287.

[¶] Ag. Sci., I, 227.

In our work with tomatoes and egg plants there has in no case occurred an instance of immediate effect, other than alteration of form due to insufficient pollen. During the past winter numerous crosses and hybridizations of tomatoes have been made. The accompanying photographs of the most violent of these crosses indicate the entire absence of apparent effects.

Figure 1 represents the "Lorillard," crossed by pollen of the "Currant," (*Lycopersicum esculentum* crossed by *L. Pimpinellifolium*). The Lorillard is a smooth, nearly spherical variety, of medium size, and as grown under glass, seldom weighs more than three or four ounces.

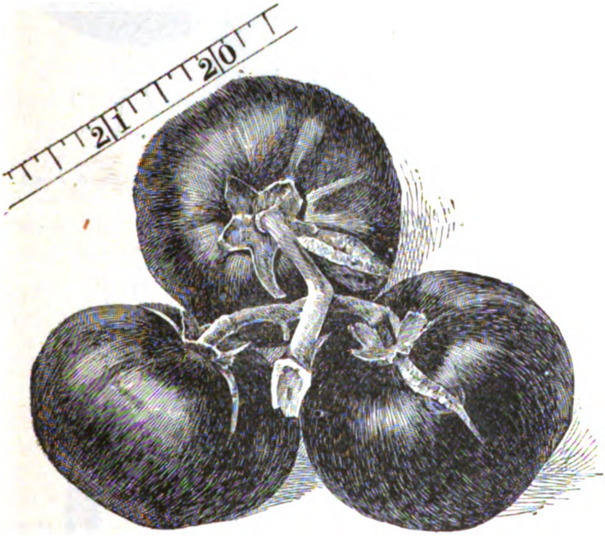

Fig. 1. *Lorillard* × *Currant.*

As will be seen, the fruit is in every respect typical of the Lorillard. The offspring from this cross, however, show unmistakable evidences of the influence of the male parent, both in the habit of the plants and in the character of the foliage and flowers. The fruit also is intermediate between the parents in size and character.

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* Bul. 25 Cornell Univ. Exp. Sta., 181, (Dec., 1890).

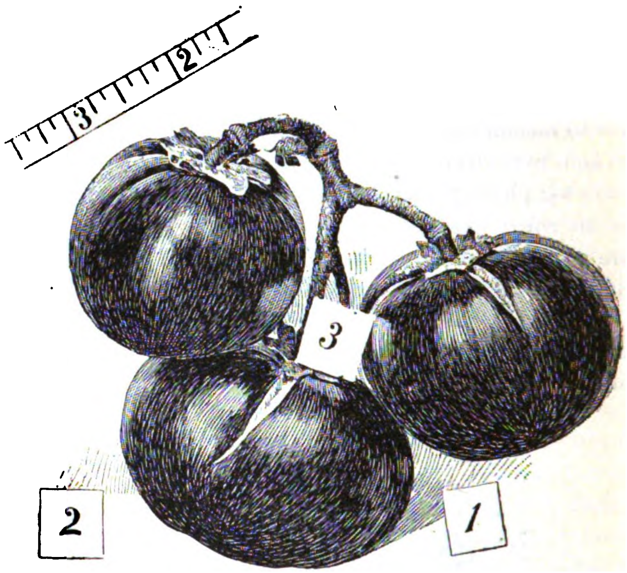

Fig. 2. *Lorillard × No. 1 Lorillard; No. 2, Currant; No. 3. Peach.*

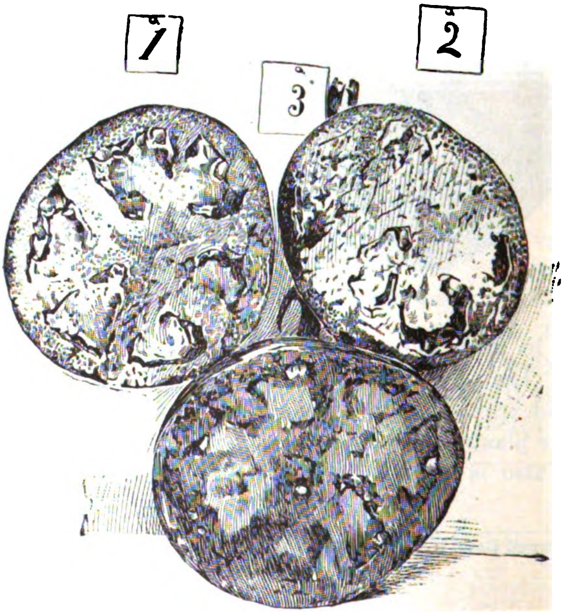

Fig. 3. *Section of Fruits shown in Fig. 2.*

Figures 2 and 3 are from photographs of a cluster in which each fruit has a different male parent. The variety used was the Lorillard. Number 1 received pollen of the same variety, while number 2 was given pollen from the "Currant," and number 3 from the "Peach." As in the previous instance, there is no apparent effect on the form of the fruit; and the seeds gave no indication of the different parentage—all were apparently typical Lorillard seeds.

In the offspring, the differences are very marked. The lines are sharply drawn between the crosses with Peach and Currant, the influence of the respective male parents being very evident, while the Lorillard cross is apparently unaffected by either of the others; indicating that there was no error in the operation, also that there has been no transfer of influence along the short peduncles, as suggested by Lowe.*

In an extended series of experiments with egg plants, conducted for three consecutive years at the Cornell University and the Maine State College, the most widely varying types have been crossed. In no instance, however, has there appeared an immediate effect of the male parent. The little Round White when crossed with pollen from Black Pekin, differed in no respect from other fruits on the same plant. But the offspring of this cross showed very marked variations. The same facts were observed regarding several other crosses.†

As before noted, instances have been reported in which the color of flowers was apparently changed by the action of foreign pollen the current season. An instance of such change has never come under my observation, though I have made numerous crosses of different varieties of Tropæolum, Fuchsia, Silene, Phlox, Petunia, and other ornamental plants.

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* See page 54.

† Bailey and Munson, Experiences with Egg Plants, Bul. 26 Cornell Ex. Sta., p. 14.

As indicating the range over which the study of the subject has extended, a partial list of the species considered by different observers is given.

Species in which immediate influence of pollen is said to have been observed:

Amaryllis vittata
Arabis blepharophylla
Cattleya Leopoldi
Citrus aurantium
Gossypium Barbadense,
Lilium bulbiferum
Lilium davuricum
Matthiola annua
Phaseolus vulgaris
Pisum sativum
Rhododendron dalhousiæ
Verbena -sp.
Zea Mays

Species in which no immediate effect appears to occur:

Cucumis melo
Cucumis sativus
Cucurbita maxima
Cucurbita moschata
Cucurbita pepo
Datura Stramonium,
Datura inermis
Fragaria Virginiana
Fuchsia sp.
Lycopersicum esculentum
Mitchella repens
Prunus Americana
Prinos verticillatus,
    (Ilex verticillata, Gray)
Pyrus malus
Pyrus Torringo
Pyrus Soulardi
Vitis labrusca
Petunia violacea
Phlox Drummondii
Silene armeria
Solanum melongena
Tropæolum minus

The above lists are doubtless incomplete, and in any case they must necessarily be regarded as tentative. In some of the cases cited, however, the evidence seems indisputable. As will be observed, thirteen species belonging to twelve genera in ten distinct natural orders have shown variation supposed to be due to the influence of pollen of the current generation. On the other hand, twenty-two species belonging to fifteen genera in ten natural orders, have failed to show immediate effects. Of the thirteen species showing immediate influence of pollen, four—the orange, the bean, the pea and Indian corn—are of much value as food plants; while eleven species, or one-half of the whole number considered which have not shown this influence, are also important food plants. These eleven species include many of the leading fruits and vegetables, such as the apple, plum, strawberry, grape, tomato, egg plant, pumpkin, squash and melon. The strongest evidence both for and against the proposition is obtained from these species of economic importance; but the question is still an open one.

As yet there are no satisfactory data on which to base general conclusions. It would be unwise, at the present time, to assert that the directing influence of pollen does or does not as a rule extend beyond the fertilization of the seed. It seems not improbable that pollen from a vigorous plant may make an imprint of its character on the female organism which shall be different from that of a less vigorous male parent. It is probable, however, that the vigor and inherent vitality of the plant operated upon usually determines whether this be manifested. Some species show apparently unmistakable evidences of the influence of foreign pollen—this is notably the case with peas and Indian corn. On the other hand cucurbitaceous and solanaceous plants seem to resist all foreign influence; while rosaceous plants are in dispute, with the weight of authority tending to show the absence of immediate influence.

II. ON THE DEVELOPMENT OF THE OVARY WITHOUT FECUNDATION OF THE OVULES.

A common, though not an universal law of reproduction by seed requires fertilization of the ovules as a condition necessary to the development of fruit. It is a matter of common observation that, as a rule, when pollination fails to result in fertilization, or when pollen is withheld, not only the pistil withers, but the entire flower decays and falls. (Pollination is used in the sense of cöition in the animal kingdom, and does not necessarily result in impregnation). Instances are not infrequent, however, which point to a responsive action on the part of the pistil or other portions of the flower receiving pollen, while from an insufficient quantity of pollen, lack of affinity on the part of the species crossed, or some other cause which remains to be determined, fertilization does not occur. Examples of this are specially common in all of our cultivated fruits and vegetables.

About the close of the seventeenth century (1691), Camerarius had observed that a female mulberry tree once bore fruit though no male tree was in its vicinity. The fruits, however, contained only abortive seeds. Plants of *Mercurialis annua* being then brought under observation, it was noticed that while the fruits were abundant and well filled out, they began to wither when about half ripe and not one produced perfect seed.[*]

The instance of the mulberry is confirmed by Claypole who cites[†] a case within his own observation in which a pistillate tree bears fruit abundantly every year though no staminate tree is in the vicinity, and no staminate flowers have been found on the tree itself. The "seeds" in these fruits, as in the other instances, contain no embryos. Whether this is a case of development in the entire absence of pollen, as circumstances would indicate, or whether there may have been a limited supply of pollen at hand, it is evident that the ovaries developed independently of any action on the ovules.

Dr. Masters is authority for the statement that certain varieties of pears habitually produce seedless and coreless fruit.[‡] In the same way it is not uncommon to find the capsules of many herbaceous plants fully developed while the seeds are absent. M. Jean Sisley, a well known French horticulturist, found this to occur with great frequency in case of the geraniums and pelargoniums. Of one hundred flowers of *Geranium platypetalum* artificially pollinated, not one produced perfect seeds, and of a large number of capsules sent by another party, nearly all were without seeds.[§]

Naudin, as a result of his studies of the genus *Cucurbita*, suggested the possibility of a specific effect of pollen in exciting growth of the ovary; and this theory is supported by Focke, who says: "Pollen has two actions on the female organs, one on the seeds, and one in exciting the growth of the fruit."[||] The theory seems plausible, and in view of the many examples of well developed but empty seed pods, it would seem that the stimulating action is alone exerted in some instances. These examples are specially common among peas and beans.

The accompanying photograph, Figure 4, represents the natural size of a Lima bean which failed to develop seeds—the undeveloped ovules may be seen at the right. Similar instances are very common in all varieties of this class.

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[*] *R. J. Camerarii Opuscula Botanici Argumenti*, cited by Sachs, Hist. of Bot. 386.

[†] Rep. U. S. Dept. of Ag. 1887, 318.

[‡] Nature, XXXV, 12. (Nov. 4, 1886.)

[§] Gard. Chron. N. S. IV, 654.

[||] Focke, Die Pflanzen mischlinge, 447.

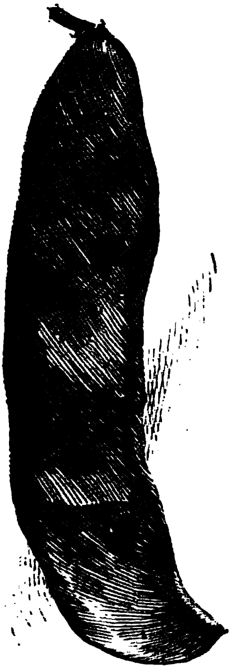

Fig. 4. *Lima Bean, Seedless, (Natural Size.)*

According to Hildebrand,* in the case of several orchids the plant's own pollen is necessary for the development of the ovarium; and this development takes place long before the pollen tubes have reached the ovules. So in these cases the pollen acts directly on the ovarium.

Disregard of the fact discovered by Camerarius, but not emphasized by him, that certain diœcious plants occasionally have monœcious individuals, has lead to many erroneous statements regarding the influence of the male element on the ovary. Hemp and Spinach have been cited† as examples of development without fertilization. It is well known, however, that both of these species have monœcious individuals, thus furnishing a source of error in observation. The Muskmelon, *Cucumis melo*, is another instance in point. This fact first attracted my attention when attempting to perform some artificial hybridizations between *Cucumis melo* and *Cucumis sativus*. The female blossoms on the variety under consideration, "Emerald Gem," were found to bear partially developed stamens. These stamens varied in size and in the amount of pollen produced, but subsequent developments indicated that enough pollen may be produced to secure self-fertilization. At the Cornell University Experiment Station several blossoms of this variety from which foreign pollen was excluded developed apparently normal fruits. In these cases of probable self-fertilization, however, there were no perfect seeds.

Darwin cites, on the authority of Dr. Hooker, an instance of the development of the ovarium of a certain orchid—*Bonatea speciosa*—as a result of simple mechanical irritation of the stigma.‡ So far as I am aware, this observation has never been verified, and it is questionable, in view of the facts here considered, whether the development would not have been as complete in the absence of the irritation.

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*Botanische Zeitung, No. 44 et. seq. Oct. 30, 1863, and Aug. 4, 1865—cited by Darwin, An. and Plts. Under Domest. I, 434.

†Le Maout and De Caisne, System of Botany, 152; also Spallanzani, quoted by Sachs, Hist. of Bot. 424.

‡An. and Plts. Under Domest, I, 434.

The fact that in growing English forcing cucumbers for market, gardeners never practice artificial pollination, as is necessary with the varieties commonly grown in this country, raised the question as to whether any pollen is required, and what proportion of the fruits would develop without fertilization. Several different varieties have been under consideration at different times. In case of the "Telegraph," a long slender variety, more than twenty blossoms before expanding were covered with paper bags —thus preventing all possibility of the access of pollen. Out of this number but two developed fruits. These were typical in form and of average size—being about sixteen inches long and two and one-half inches in diameter. They contained a large number of partially developed ovules—some of them 3-8 inch long—extending nearly the whole length of the fruit. There were no perfect seeds, however, as shown by Figure 5.

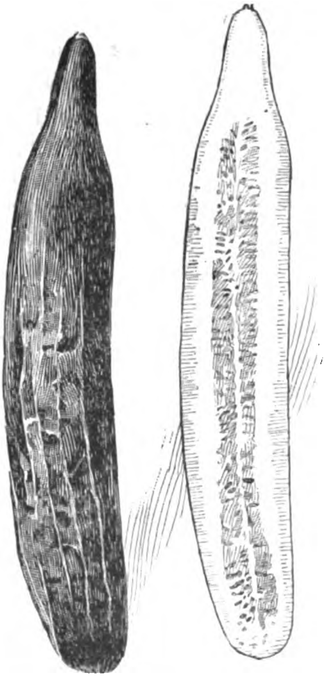
Fig. 5. *Telegraph, Seedless.*

Of ten blossoms of the variety known as "Sion House," covered as above, one developed fruit. Later many other blossoms were covered and some fruits were developed, but the percentage was about the same as before. The fruits, as with the "Telegraph," were straight and smooth and contained an abundance of partially developed ovules along the whole length of the fruit; but there were no perfect seeds. Other fruits of both varieties, left to natural conditions, were examined and as a rule were found to contain no perfect seeds. Indeed, this absence of seeds is a matter of common observation, and is urged as a point of excellence in favor of the English varieties. In one instance two or three apparently good seeds were found, but no embryo was present, while most of the ovules were only one-eighth to one-fourth inch in length. There are few if any insects in a forcing house in midwinter which would be likely to carry pollen; and it is probable that fruits left to natural conditions received no pollen.

Other varieties exhibit characteristics peculiar to themselves, when pollen is withheld. "Blue Gown," for example, is almost invariably withered and shrunken at the apex or "blossom end," as shown in Figure 6. The same tendency is shown by the "Duke of Edinburg." No seeds are developed in these fruits, and at maturity they are often hollow at the lower end as shown in Figure 7.

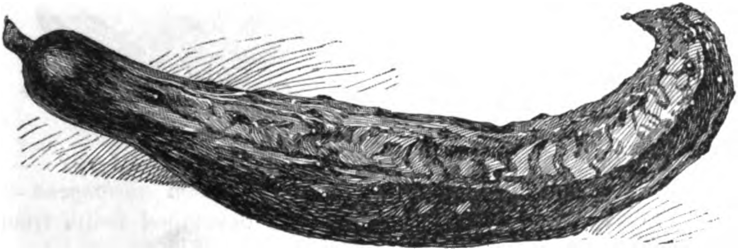

Fig. 6. *Blue Gown, not Pollinated.*

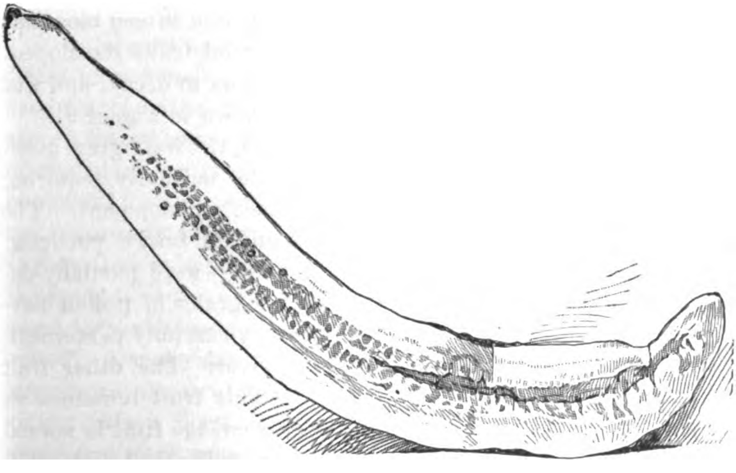

Fig. 7. *Duke of Edinburg, not Pollinated.*

In several instances I have observed the development of fruits on the "Duke of Edinburg," when the blossom never expanded. One of these is shown in Figure 8. The mature fruits were in every respect like those from which pollen was excluded by artificial means.

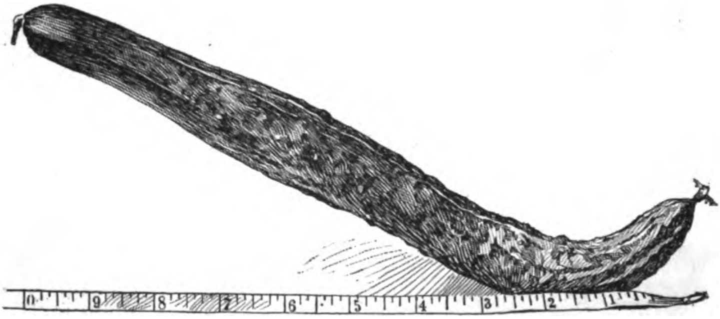

Fig. 8. *Duke of Edinburg.*

In our studies of the egg plant — *Solanum melongena* — we have at different times secured well developed fruits from blossoms which had been castrated and covered with paper bags to prevent access of foreign pollen. In no case have perfect seeds been found. The first instance noted was in the summer of 1890, and the fact was published the following spring.* During the past winter, 1891-92, experiments in this line have been repeated on plants growing in the house. Out of fifteen blossoms emasculated and covered, two apparently good fruits developed. One of these when about six weeks old began to decay, and was picked, and photographed. This fruit is shown in Figure 9.

As will be observed, the outer portions of the fruit grew much more rapidly than the inner,— the placentæ evidently requiring the stimulus of the growing ovules to induce development. The abortive ovules appear in the cavity as minute brown particles. A very few of them — ten in the whole fruit — were partially developed; indicating the possibility of a few grains of pollen having reached the stigma. The work was very carefully performed, however, and I am confident there is no error. The other fruit referred to is shown in the frontispiece. This fruit remained on the plant until fully mature. As will be seen, the fruit is normal in every respect except that it is *absolutely* seedless.

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*Bailey and Munson, Experiences with Egg Plants. Bul. 26, Cornell Exp. [illegible] 19.

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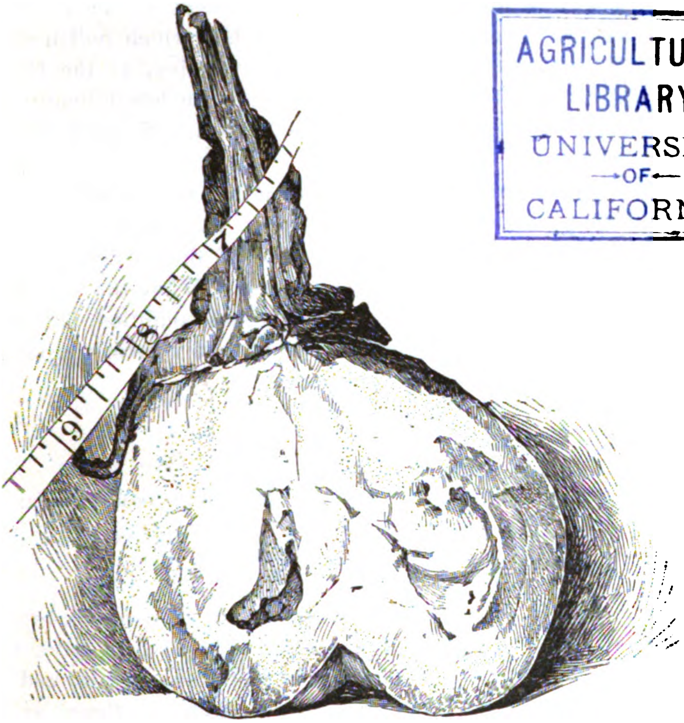

Fig. 9. *Egg Fruit, not Pollinated.*

It is interesting in this connection to note the fact that these fruits have usually, though not invariably, developed on cross-bred plants, rather than on fixed varieties,— a fact apparently in accord with the supposition before expressed, that excessive vigor of the plant is a prime requisite for the appearance of the phenomenon; for I have observed that as a rule, the cross-bred plants are apparently stronger and more productive than the others.

A further indication that excessive vigor of growth may affect the fruit, is in the abnormal development of the calyx of the egg plant in many instances, while the growth of the ovary is arrested. Usually the most prominent indication that impregnation has taken place, in the egg plant, is the rapid growth of the calyx. Many times, however, the calyx becomes much enlarged while for some reason the ovary fails to develop. I have frequently seen examples of this, in which the calyx was fully six inches long.

Another instance of the partial developnent of the ovary was observed in a Summer Crookneck squash to which pollen of another variety was applied by Professor Bailey, at the Cornell University. The fruit attained about eight inches in length, and remained in this condition during the season. No perfect seeds were developed.

From the evidence adduced the fact seems well established that in certain species, the ovary may develop and reach normal size without the corresponding impregnation of the ovules, and even in the entire absence of the male element. What the conditions are which induce this apparently abnormal condition, is not fully determined. It is evident, however, that vigorous growth of the parent plant is of first importance.

III. ON THE AMOUNT OF POLLEN REQUIRED FOR FERTILIZATION; AND THE EFFECTS OF POLLINATION ON THE FORM AND SIZE OF THE FRUIT.

Kœlreuter, in 1761-66, found that with *Hibiscus venetianus* fifty to sixty pollen grains were sufficient to produce more than thirty fertile seeds in the ovary. In *Mirabilis jalapa*, and *M. longiflora*, which have a one ovuled ovary, two or three, and in some cases even one grain was sufficient for fertilization.† Now, according to Kœlruter, the Hibiscus produced 4863 pollen grains in a single flower,—or eighty-one times more than needed for actual fertilization. So also the Mirablis produced about 300 grains, or from 100 to 200 times too much. It appears therefore that there is no relation between the amount of pollen produced by a plant, and the amount required for fecundation.

Since the time of Kœlreuter, little has been done toward determining the actual number of grains required for the fertilization of any given species; but the fact has been plainly demonstrated that the amount of pollen applied may have great practical importance in determining the form and size of the fruit, as well as the quantity of fruit produced.

In crossing strawberries at the New York Agricultural Experiment Station, the fact was plainly brought out,‡ that the proportion of berries secured depends upon the abundance of the pollen furnished by the variety used as a fertilizer,— a point which is of great moment if the same law holds under natural conditions. That there may be some doubt of this, however, is indicated by the fact that certain so-called pistillate varieties — notably the Crescent — at times mature "fruit" and apparently perfect seeds in the absence of any perfect flowering variety. One grower of my acquaintance uses no perfect flowering variety, and succeeds admirably. I have never seen these plants, but it is well known that the pistillate varieties frequently produce plants having partially developed stamens, and it is probable that by unconscious selection, plants of this character have been increased to a considerable extent. In any case, the amount of pollen is necessarily quite limited.

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†Cited by Sachs, Hist. of Bot. 408.
‡5th An. Rep. N. Y. Exp. Sta. 179.

That the amount of pollen used may have an important bearing in determining the form and size of the fruit is certain. This fact, which is of special importance to the horticulturist, is shown by our work with tomatoes. In the winter of 1890-91, while crossing tomatoes, two stigmas in the same cluster of flowers were given different amounts of pollen. The first was given a very small amount — 10 to 20 grains — on one side of the stigma; the other

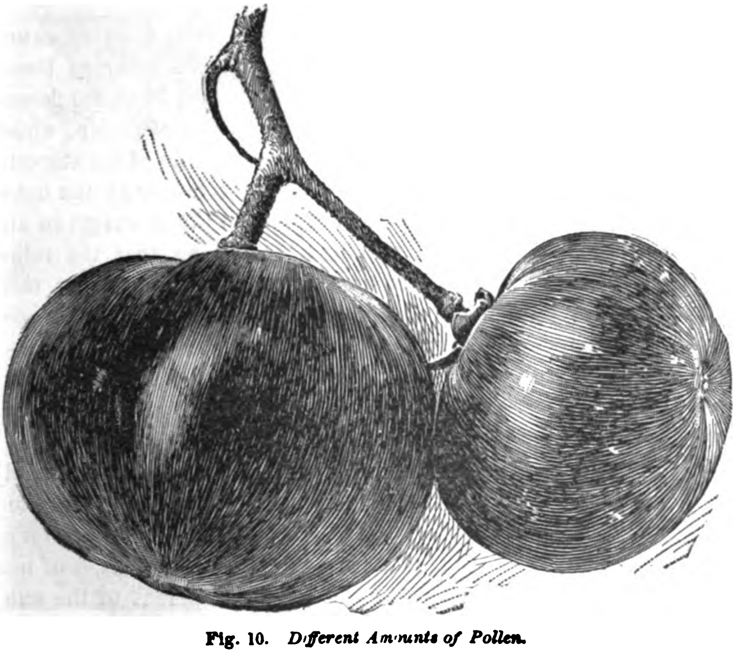

Fig. 10. *Different Amounts of Pollen.*

was given an excess of pollen, the stigma being well smeared. The effect on the form and size of the fruit was very marked. The fruit receiving the large amount of pollen was of normal size and nearly symmetrical in form, while the other was small and deformed. The larger fruit produced an abundance of seeds and all of the cells were well developed; the smaller developed seeds on one side only, while the other side was nearly solid.

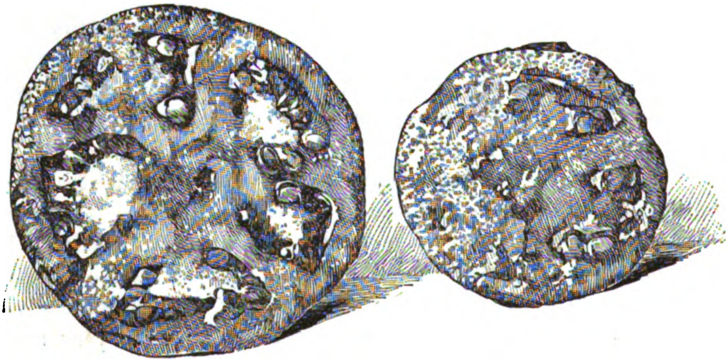

Fig. 11. *Different Amounts of Pollen.*

During the past winter the experiments have been repeated many times and the results have been uniformly similar to those detailed. In the first case, — see Figures 10 and 11 — the flower nearest the base of the cluster received an excess of pollen, while the other received a very small quantity on one side of the stigma. In another instance — Figures 12 and 13 — the flower at the base received the small amount of pollen, while the other was given an excess. Similar results were obtained, indicating that the relative position of the flower has no influence in determining this point. As will be seen from Figure 13, the seeds in this instance — but ten in number — were all born in one cell, and the deformity of the fruit was correspondingly greater than in other cases. The difference in size of the fruits was even greater in some instances than in those already cited.

The exact number of pollen-grains necessary to insure partial development of the ovary, in case of tomato, I am unable to state at the present time. Certain it is, however, that the secondary action of the pollen in stimulating the growth of the fruit is of no small importance. No doubt the greater development of the one side is largely due to fertilization of the ovules and the consequent growth of the placentæ; but that there is a further cause is indicated by the growth of the other side. Whether these results point to the possibility of securing seedless tomatoes by reducing the amount of pollen employed, is questionable. In no case have we secured fruit when all pollen was excluded, and in every case the size of the fruit was in direct proportion to the amount of pollen used.

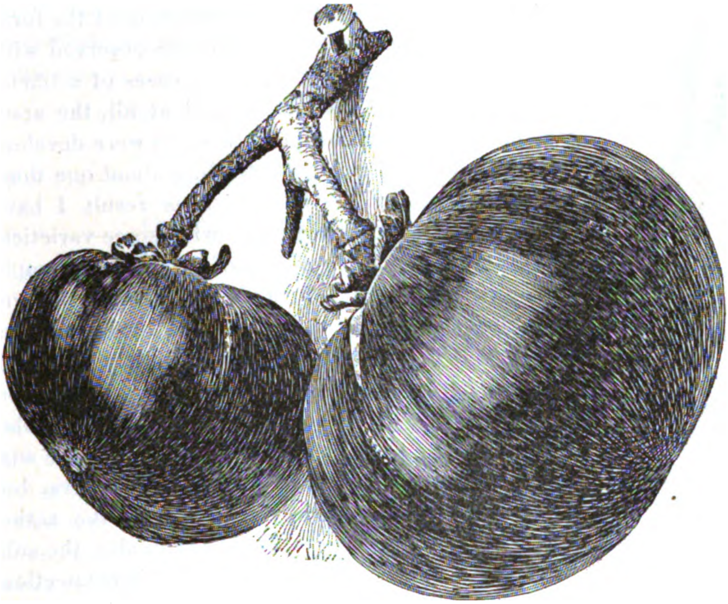

Fig. 12. *Different Amounts of Pollen.*

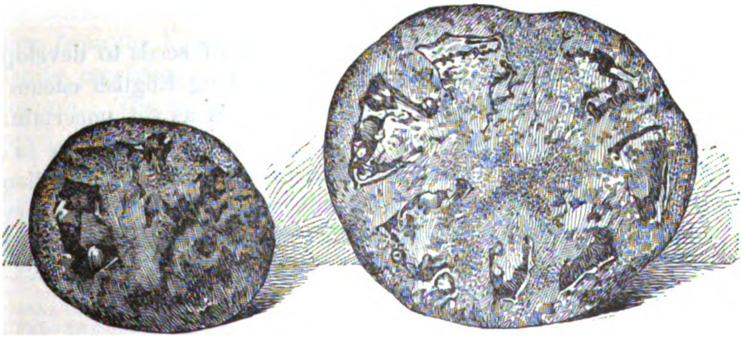

Fig. 13. *Different Amounts of Pollen.*

By careful selection we have secured tomatoes with relatively very few seeds; and Professor Bailey reports absolutely seedless fruits.* It is very doubtful, however, if these fruits can be regarded as any thing but variations. The habit of the plant has become so modified that the influence of the pollen in stimulating growth is stronger than its fecundating power. In none of the plants bearing relatively seedless fruits, was there an apparent lack of pollen.

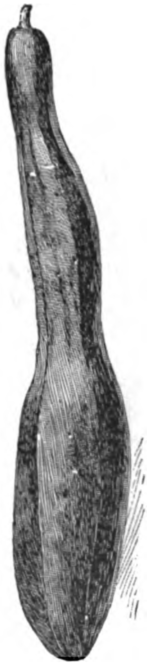
Fig. 14.
Telegraph,
Artificially Pollinated.

A further instance of the modification of the form of fruit as a result of pollination, was observed with English cucumbers. As a rule, in cases of artificial pollination, if the fruit developed at all, the apex was much enlarged and perfect seeds were developed, — these seeds usually extending about one third of the length of the fruit. This result I have found to be almost invariable with some varieties, — notably the "Telegraph", of which an example is shown in Figure 14. This peculiarity of form is the usual result of pollination in other varieties also, but it is not invariably the case, and Professor Bailey regards the irregular form as "an expression of plant variation, rather than a result of particular treatment."† Certain individuals may be more susceptible to the influence of pollen than others, but as the variation is traceable directly to the action of pollen in the impregnation of the ovules, the subject may properly be considered in this connection. At the present time, however, we can only say that as a rule this particular variation is induced by the action of pollen. The reason is yet to be determined.

In other words, the reason for the failure of seeds to develop throughout the length of the ovary in the long English cucumbers, when pollen is applied to the stigma, is as yet uncertain. It appears probable, however, that the explanation lies in the extreme length of the ovary and the consequent inability of the pollen tubes to penetrate so far. There has been a variation in the ovary without a corresponding variation in the pollen. The amount of

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*Rep. Cornell Univ. Exp. Sta. 1891, 55.
†Bailey, Bul. 31 Cornell Univ. Exp. Sta. 137.

pollen applied, appears to have little effect in regard to this point.

In general, while little accurate work has been done in the way of determining the exact amount of pollen necessary for fertilization, it appears that the question has bearings of much practical importance. In some instances the size of the fruit seems to be in direct proportion to the amount of pollen used, while the form is much improved by an abundant supply. In some cases, on the other hand, fruits will develop without the intervention of the male element, and the best results are obtained when pollen is withheld.

IV. ON THE GENERAL INFLUENCE OF FOREIGN POLLEN, AND OTHER MISCELLANEOUS OBSERVATIONS.

As already intimated, pollen appears in many cases to act directy on the ovary, stimulating growth of that organ independently of any effect on the ovules. This fact is most clearly seen in those species which do not readily cross.

In this connection, Focke remarks: "The pollen of the species acts quicker than foreign pollen and is alone effective if mixed with foreign pollen upon the stigma. * * * It is probable that if the pollen of the species is insufficient, foreign pollen may serve to develop the fruit, and thus serve a purpose."* Some instances strongly supporting this proposition have come under my observation.

One of the large English cucumbers, "Duke of Edinburg," was given pollen of the "Emerald Gem" muskmelon. The cross was made in February. The resulting fruit attained about one-half the normal size and then ceased growing. When the vines were torn from the house in June, this fruit was still green while other fruits, receiving pollen of the species two months later, were fully mature. The ovules in the fruit in question were wholly undeveloped.

Two other instances of a similar nature were observed. The first of these was the common Summer Crookneck squash crossed by the American Turban—Figure 15; while the second was the same variety crossed by Mammoth Tours pumpkin—Figure 16.†

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*Die Pflanzen mischlinge, 448.

†The two crosses last named were made by Professor L. H. Bailey at Cornell University. All other illustrations are from work performed by the writer.

In both of these cases the fruit developed, as indicated, about six inches in length, and remained in that condition several weeks. No seeds were developed, and late in the summer the fruits began to decay.

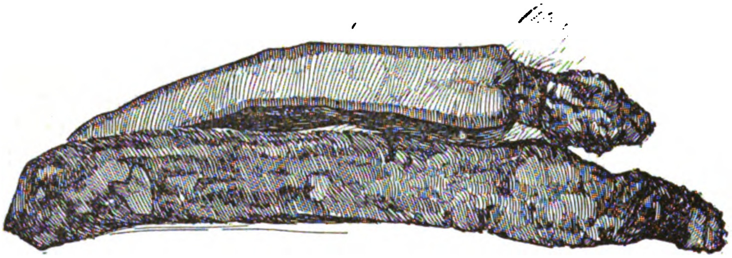

Fig. 15. *Summer Crookneck × American Turban.*

A most remarkable instance of secondary influence of foreign pollen is that recorded by Lowe.* Flowers of the yellow musk plant, *Mimulus luteus*, were crossed with *Mimulus cashmerianus* which has spotted flowers. When the pods from these flowers were nearly matured, other flowers upon the same branches were given pollen of *M. luteus*. More than one hundred seedlings were grown from these latter crosses and every one bore spotted flowers. In other words, the influence of the pollen of the foreign species was transferred along the branch and overcame the influence of pollen from the same species. (!)

This result is in direct opposition to Focke's principle of the prepotency of pollen of the species as compared with foreign pollen, and as yet, so far as I am aware, Lowe's statements have not been verified. I have undertaken to prove the truth or error of the statements, but have not as yet reached conclusions.

Superfœtation: Is it possible that the progeny of any plant may be in any way affected by the application of foreign pollen to the stigma after self-fertilization has already taken place? Is it possible to obtain distinct effects from two male parents when the pollen is applied at different times?

Comparatively little has been done towards solving these questions, and they are suggested as promising lines of investigation rather than as subjects for extended discussion at this time. Both Gray† and Focke‡ have denied the possibility of superfœtation, but other observers have cited instances in support of the theory and certain facts have come within my own observation which point to the possibility of several seeds in the same ovary being the product of different male parentage.

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*E. J. Lowe, Rep. British Ass'n for Adv. of Sci. 1885, p. 1081.

†Am. Jour. Sci. and Arts XXV, 123.

‡Die Pflanzen mischlinge, 448.

Grieve, in 1874,* individually pollinated several blossoms on some plants of *Pelargonium peltatum.* One of these plants was on the day following given pollen of *Pelargonium zonale.* The offspring of the first plant were all true *Pelargonium pelatum;* while of the offspring of the second, no two were alike, the leaves of some being large and of others small; some showed a well developed zone, while others were without any indications of this character.

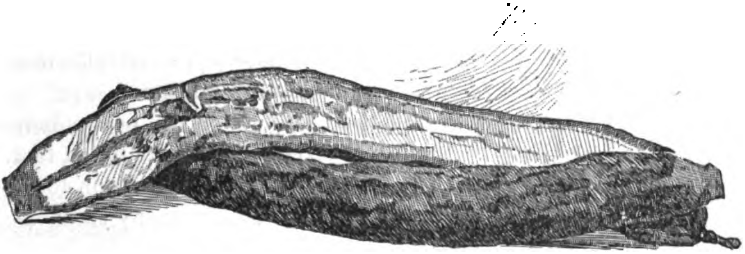

Fig. 16. *Summer Crookneck × Mammoth Tours Pumpkin.*

Charles Arnold, in crossing corn, used pollen from both a yellow and a white variety, on pistils of a dark purple sort. The resultant grains were yellow at the base and white at the top; while those of another ear on the same stalk, being individually pollinated, were of normal color.† This instance established in the mind of Mr. Arnold the fact of the possibility of superfœtation, and was used by Thomas Meehan‡ as the basis for an argument in support of the theory of the immediate influence of foreign pollen as well as of the theory of superfœtation. So far as I am aware, similar results have not since been obtained.

In applying small amounts of pollen to the stigmas of tomatoes, I have observed that the portion of the stigma receiving pollen soon turned brown and withered while the other side remained green and in an apparently receptive condition for some time. This fact was specially apparent in the fruit shown in Figure 12. As seeds develop only on the side receiving pollen, it seems probable that seeds on the other side of the ovary might well be fertilized by pollen of a different variety or species. This point is now receiving special attention.

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*Gard. Chron. Vol. II, (N. S.), 689.
†Gard. Month. XV, 104.
‡Proc. Phil. Acad. Sci. 1873, 16.

CONCLUSION.

From a study of the laws of heredity, conclusions of vast importance in the systematic amelioration of plants have been reached. At the present time, however, but little is known of the laws controlling the numerous secondary results attending the crossing of plants. From the evidence at hand it appears that the secondary results may be of fully as much importance as are directly inherited qualities.

There is little doubt that in a few important species there may be an immediate apparent effect of foreign pollen on the female organism of the current generation. It is equally certain, however, that the greater portion of food plants which have received special study do not exhibit any immediate apparent effects of foreign pollen; while other species are still in dispute.

That pollen has a direct stimulating effect on the ovary, independently of its action on the ovules, seems a well established fact. In many cases the size of the fruit is in direct proportion to the amount of pollen used; but it is also true that in many cases the fruit may develop to a considerable degree, or even to its normal size, in the entire absence of the male element. What the conditions are which insure this phenomenon is as yet uncertain. Exceedingly vigorous growth of the plant is certainly a first requisite, but there also seems to be an individual variation in this direction, with some species.

Variations in the amount of pollen available, may to a large extent determine the form and consequent value of the fruits of some species. It is certain that in some instances — as with tomatoes — the best practical results are obtained from an excessive supply of pollen; while on the other hand, some fruits — as is true of the English cucumber — may be of better form if pollen is withheld.

Whether superfœtation is possible, is a question of no small importance, but the evidence is as yet insufficient for conclusions to be drawn.

With all cultivated plants there is a tendency to revert to ancestral forms, and it is important that this fact be borne in mind in assigning definite causes to results obtained; otherwise, erroneous conclusions will often be reached.

GENERAL SUMMARY.

1. The evidence at hand indicates that within certain limits there is an immediate influence of pollen on the mother plant; but that these limits are quite restricted.

2. The most important plants showing, unmistakably, immediate effects of foreign pollen are the pea, the kidney bean and the Indian corn. It is possible that the orange may be included in this list.

3. Sweet corn shows the effect of foreign pollen more frequently than do the other races of corn

4. Cucurbitaceous and solanaceous plants have not been fonnd to exhibit immediate effects of pollen.

5. Rosaceous plants are in dispute, but the weight of authority would indicate an absence of immediate effect.

6. The theory of the double action of pollen—stimulating as well as fertilizing—as suggested by Naudin and Focke, seems plausible; but in some species the ovary will develop in the entire absence of pollen.

7. The most important examples of agamic development of fruit, are seen in the Egg Plant—*Solanum melongena*—and the English forcing cucumber—*Cucumis sativus.*

8. In no instance, when pollen is witheld, are perfect seeds developed.

9. There appears to be no relation between the amount of pollen produced by a plant and the amount required for fecundation.

10. There appears to be no relation between the amount of pollen produced by a plant and the number of seeds produced by its fruits.

11. The amount of pollen applied may in many cases be of great practical importance in determining the form and size as well as the quantity of the fruit produced.

12. The amount of fruit produced by certain varieties of strawberries appears to vary, in some instances, with the amount of pollen supplied by the variety used as a fertilizer; but this occurrence is not universal.

13. The form and size of tomato fruits are directly dependent on the amount of pollen furnisheda,— small amount invariably resulting in small and deformed fruit.

14. **The English forcing cucumber is usually deformed by the production of seeds and the consequent enlargement of the apex, as a result of pollination; the amount of pollen used appears to be of no importance in determining the extent of the deformity.**

15. **Pollen appears in many cases to act directly on the ovary, stimulating growth of that organ independently of any effect on the ovules,—an effect most clearly seen in those species which do not readily cross.**

16. **Indications point to the possibility of distinct effects from two male parents when pollen is applied to the same stigma at different times.**

REPORT OF THE HORTICULTURIST.

W. M. Munson.

In many respects the work of the horticultural department has been a continuation of that of last year. As indicated in my last report two distinct lines of work are in view; one being a study of principles and the laws affecting plant growth; the other a practical investigation of ways and means for immediate guidance in the culture of fruits and vegetables.

In studying the variations of plants, it is interesting and important to know what results may be expected from certain of the operations performed in the process of amelioration. During the past year special attention has been given to a study of the effects of pollination. The results of this study were published as Part II of the annual report of the experiment station. The field for investigation in this direction is very promising.

The work with insecticides and fungicides has been continued during the year and valuable lessons have been learned. Owing to the excessively wet season, results were not so marked as last year, but the beneficial effects of spraying are evident, and further effort in this line is warranted.

In our work with vegetables the tendency is to specialize rather than to grow a large number of varieties—particular attention being given to cabbages, tomatoes and egg plants. In the forcing house the pepino and the English cucumber, as well as the tomato, lettuce, radishes and other common crops demand attention. It is believed that with proper management the pepino may be made a profitable crop for winter forcing in those localities which can command a fancy market. A special report concerning the forcing of vegetables is now in preparation.

The fruit plantations have been largely extended and systematized, and with the provisions for increased assistance next year it is hoped the work may be prosecuted with renewed vigor.

THE VEGETABLE GARDEN.

While a greater variety of vegetables was grown during the past year than in 1891, we shall confine our report at this time to certain notes concerning cabbages, tomatoes and egg plants. Other important vegetables will receive attention at a later date.

I.—NOTES OF CABBAGES.

As in the previous season, the study of cabbages was confined mainly to a few questions relative to methods of culture,—including the effects of handling; effects of trimming; a comparison of varieties, and the testing of the newer varieties.

No strictly new varieties were grown this year. "Nonesuch" and "Worldbeater," which were grown for the first time last year, were tried again and the good opinion expressed at that time regarding the first variety is confirmed. It is a very good second early sort. The average weight of this sort was about eight and one-half pounds. "Worldbeater" is a little later and in no way so satisfactory. The average weight of the heads is about the same as that of "Nonesuch."

Seeds from Long Island and from Fidalgo, Washington, did not give widely different results. The plants from both lots were very strong and vigorous from the start.

1. *Effects of Trimming:* It is frequently asserted that cabbage plants will thrive much better and give better results, if the leaf surface is reduced by about one-half at time of transplanting; since little growth will be made till the roots become established and the first leaves usually wither and fall away. To test this point, a number of plants of several varieties were trimmed at the time of setting in the field, while others of the same lots were not disturbed. Rain fell soon after the plants were set and all of them grew remarkably well. The results are shown in the table.

TABLE I.—EFFECTS OF TRIMMING CABBAGE PLANTS.

VARIETY.	No. of heads.	Total weight. lbs.	Heaviest head. lbs.	Lightest head. lbs.	Av'ge weight. lbs.	No. of heads cracked.	No. heads immature.	No. heads not cut.	Ratio.
EARLY SUMMER.									
Trimmed......	8	24.0	3.75	2.25	3.00	0	0	0	1.00
Not trimmed..	6	22.1	4.75	2.50	3.70	0	1	2	1.23
ALL SEASONS.									
Trimmed......	15	116.5	12.87	3.87	7.77	1	0	1	1.28
Not trimmed..	11	66.5	11.50	2.19	6.05	0	3	0	1.00
WORLD BEATER.									
Trimmed......	15	124.5	11.75	4.56	8.30	1	0	0	1.00
Not trimmed..	17	143.0	13.37	5.37	8.40	0	0	0	1.00

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As will be observed, there is little difference in the average weight of the heads from trimmed and untrimmed plants. With one variety the ratio is decidedly in favor of the trimming, while with another the indications are generally as positive in the opposite direction; while the third is neutral.

Conclusion: From work performed, it is impossible to make definite statements as to the value of trimming cabbage plants at time of setting.

2. *Influence of Transplanting:* Limited space in the forcing house prevented the continuation of this experiment on a scale as extensive as had been planned. A number of plants of two varieties, however, were given the same treatment as last year, *i. e.*: The plants handled in pots were removed from the seed-flats to three-inch pots, and later to four-inch pots. Those handled in boxes were placed two inches apart at the first transplanting and about four inches each way at the second. The boxes used were ordinary seed-flats, 16x20 inches, and about three inches deep. When placed in the field, all were set in rows three and one-half feet apart and two feet apart in the rows.

The results are shown in table II.

TABLE II.—POTS VS. BOXES.

VARIETY AND TREATMENT.	No. of heads.	Heaviest head. lbs.	Lightest head. lbs.	Av'ge weight. lbs.	No. of heads cracked.	No of heads immature.	No. of plants not cut.	Ratio.	Remarks.
JERSEY WAKEFIELD. (Brill.)									
Pots	22	5.50	2.00	**3.50**	7	1	0	**1.42**	Cut Aug. 4.
Boxes....................	56	5.94	.87	**2.47**	5	12	2	**1.00**	
STEIN'S FLAT DUTCH. (Thorburn.)									
Pots	17	12.87	4.31	**8.62**	5	0	0	**1.12**	Cut Aug. 24.
Boxes....................	24	13.00	2.94	**7.67**	4	0	0	**1.00**	

In each instance the average weight of the product is decidedly in favor of the plants handled in pots. This result confirms that obtained last season with the first variety, but contradicts that obtained with the second. The plants handled in pots were manifestly earlier and better than those from boxes, and the question now arises, whether the difference is sufficient to warrant the additional expense.

It is of interest to note that *Jersey Wakefield* seems specially susceptible to good treatment. In 1891 the ratio of the pot-grown plants to those grown in boxes was as 1.38 : 1.00, while the present season, as will be seen from the table, the ratio is as 1.42 : 1.00. Plants of this variety which were set deeply have almost invariably given better results than those set shallow, while other varieties have given various results in different years, though the same treatment was given.

Conclusion: The results are contradictory to those obtained in 1891, and indicate that pot-grown cabbage plants are earlier and better than those grown in boxes.

II.—NOTES OF TOMATOES.

The number of varieties grown the past season was not so large as in 1891, attention being given more particularly to methods of culture.

1. *Effects of Early Setting:* From our study of this subject last season, we found that: "On a warm, sandy soil, the earliness and productiveness of tomatoes were in direct ratio to the earliness of setting in the field," and that "a chill is not as fatal to success as is commonly supposed."* Accordingly, our principal setting was made on June 1st this year—nearly two weeks earlier than usual in this climate.

To verify the conclusions reached last year, when only one variety was used, three dozen plants of each of four varieties were set apart and given the same treatment in every way while in the house, all being transferred from the seed flats to 2-inch pots, then to 3-inch, and finally to 4-inch pots. The season being somewhat backward, the first lot was not put out until May 19. The other two lots were put out June 1st and June 15, respectively.

The night following the first setting there was a slight frost and the weather was cold and raw for a week following. As the plants were taken directly from the hot house, without "hardening off," the test was a severe one.

Table III shows very clearly the results obtained from this trial.

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* Rep. Maine Exp. Sta. 1891, p. 91.

TABLE III.—Early and Late Setting.

Varieties.	Date of setting.	No. of plants.	Av. No. fruits per plant.	Av. wt. of fruits per plant. lbs.	Av. wt. of individual fruits. oz.	Date of first ripe fruit.
Early Ruby.						
1st setting	May 19.	8	22.6	5.87	4.2	July 29.
2d "	June 1.	11	18.3	4.47	4.2	" 26.
3d "	" 15.	11	7.7	1.69	3.5	" 22.
Atlantic.						
1st setting	May 19.	12	10.2	2.14	3.4	Aug. 1.
2d "	June 1.	10	9.3	1.89	3.2	July 29.
3d "	" 15.	12	5.3	0.98	2.9	" 22.
New Jersey.						
1st setting	May 19.	12	12.8	5.19	6.5	Aug. 9.
2d "	June 1.	12	12.0	5.00	6.7	" 8.
3d "	" 15.	12	4.4	1.33	4.8	" 6.
Beauty.						
1st setting	May 19.	12	18.4	7.10	6.2	Aug. 9.
2d "	June 1.	10	16.6	6.60	6.4	" 1.
3d "	" 15.	12	1.4	0.17	1.9	" 8.

From the table we learn first of all, that the first ripe fruits, in every instance save one, were obtained from the plants set latest. This fact, however, is not necessarily an indication of earliness, as the late-set plants were older than is usually desirable for setting and the first fruits were in some cases from blossoms formed while in the house. After these had ripened there was a long interval before others followed.

Without exception, the average number of fruits and the average weight of the product per plant, was in direct ratio with the earliness of setting,—a direct confirmation of results obtained last year. The average weight of individual fruits was not essentially different in the first two settings, but was decidedly less in the last lot.

2. *Effects of Bagging Fruit*: The editor of one of the leading agricultural papers* last year suggested covering the fruit with paper bags, as a means of inducing early ripening, claiming that in this way maturity might be hastened by several days. It is impracticable to cover individual fruits, but whole clusters on different plants of several varieties were covered and duplicate clusters of the same age were marked for comparison.

The following notes indicate the results:

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* Rural New Yorker.

			Size at time of covering.	Date of ripening.
IGNOTUM.				
	1	Covered July 14........	Size of pea.	Aug. 29.
		Not covered............	" "	" 19.
	2	Covered Aug. 6.........	" "	Sept. 21.
		Not covered............	" "	" 21.
PERFECTION.				
	1	Covered July 12........	" "	Aug. 19.
		Not covered............	" "	" 19
	2	Covered July 14........	" "	" 29.
		Not covered............	" "	" 19.
	3	Covered July 14........	½ inch.	" 29.
		Not covered............	"	" 18.
	4	Covered Aug. 6.........	"	Sept. 27.
		Not covered............	"	" 21.
	5	Covered Aug. 6.........	Size of pea.	" 27.
		Not covered............	" "	" 27.
PRELUDE.				
	1	Covered July 14........	½ inch.	Aug. 19.
		Not covered............	"	" 17.
	2	Covered July 14........	"	" 18.
		Not covered............	"	" 15.
	3	Covered Aug. 13........	¾ inch.	Sept. 27.
		Not covered............	"	" 27.

In no instance did the fruit ripen earlier when covered, and in more than half of the cases considered, that not covered matured first.

Conclusion: Little or no benefit seems to be derived from the practice of bagging tomato fruits.

3. *Individual Variation:* In the culture of tomatoes, as of other garden crops, conclusions as to best methods are too often drawn from the results of a single season's work. There is little doubt that many of the conclusions thus reached are often misleading, for it is believed that the individual variation of the plants of any given variety is often such as to obscure any effects of different methods of treatment.

As bearing upon this question, duplicate lots of one dozen of each of several varieties were selected at the time of the first transplanting, and were given the same treatment at all times, being handled alike in the house and set in parallel rows in the field.

The comparative results are seen in table IV.

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TABLE IV.—INDIVIDUAL VARIATION.

VARIETY.	Av. No. ripe fruits per plant.	Av. wt. of fruits per plant. lbs.	Av. wt. of individual fruits. oz.	Date of first ripe fruit.
Golden Queen	11	3.96	5.6	Aug. 8.
	20	6.00	4.9	" 4.
Ignotum	13	5.87	7.0	Aug. 1.
	12	5.23	7.2	" 1.
Perfection	24	8.90	5.8	Aug. 4.
	17	5.70	5.5	" 1.
Prelude	27	3.36	2.0	July 25.
	41	4.82	1.9	" 29.

In no case were the results obtained from the duplicate lots uniform. The variation in weight of individual fruits, and in the time of ripening, varied but slightly; but the number and weight of the product was very marked.

Conclusion: Positive conclusions should never be drawn from the results of a single season's work.

4. *Color:* As noted in last year's report, many attempts have been made to improve upon the color of the fruit of the tomato. The cross between Golden Queen and Ignotum, grown in the college gardens last year, gave no indication of any influence of the yellow parent; but the second generation was decidedly variable, about half of the plants bearing red fruits and the others yellow, with no indication of the desired blush form.

A selected strain of Golden Queen having a tendency to produce fruit with a blush cheek, is as yet only imperfectly fixed; but as grown in the house, this tendency is very nicely brought out and the fruits are very attractive.

A new variety to be introduced in 1893 by J. M. Thorburn & Co., of New York, as "Lemon Blush," is said to be a firmly fixed variety of the type sought. This variety originated with Mr. E. S. Carman, editor of the Rural New Yorker.

5. *Crossing:* Tomato growing in the high latitudes is often unsatisfactory for the reason that but a very small proportion of the fruit will mature before the plants are killed by frost. It is therefore important that some variety be secured which shall perhaps combine the size and quality of the better market sorts now extant with the earliness and prolificness of some of the smaller

sorts valuable only for preserves or catsup. With this end in view numerous crosses have been made, and the results obtained are interesting and promising.

During the winter of 1891-2 crosses were made between Ignotum, one of the most valuable market varieties, and the Peach, a very productive variety of excellent quality but small and soft.* Several plants resulting from this cross were grown in the field during the past summer, and were highly satisfactory. The fruit was in general not very different from the Ignotum, though averaging smaller; but the increase in productiveness was very marked. Whereas the average number of ripe fruits per plant on the pure Ignotum plants was but **18**, that on the crossed plants was **40**. The average weight of individual fruits, however, was but 3.3 oz. as compared with 7.5 oz. in case of the Ignotum.

In another instance two flowers on one cluster of the Lorillard were artificially pollinated—the one with Peach, the other with Lorillard pollen. The products of these crosses were given the same treatment throughout the season and were planted side by side in the field. The plants were essentially Lorillard in appearance, and the fruits as a rule were of this type, but some of the fruits showed distinctly the effects of the staminate parent.

The following figures represent very well the comparative yield of the two lots:

	Av. No. ripe fruits per plant.	Av. wt. of fruit per plant, lbs.	Av. wt. of individual fruits. oz.	First ripe fruit.
Lorillard × Peach..............................	40	8.1	3.2	Aug. 12.
Lorillard × Lorillard........................	13	4.1	5.0	" 23.

The figures are significant. As will be observed, the individual fruits of the cross with Peach are somewhat smaller than those of the pure Lorillard—being about intermediate between the usual sizes of the two parents—but the number of fruits is trebled, while the average weight per plant is doubled. The date of ripening also is hastened by more than a week. The fruit showed little tendency toward the peculiar roughness of the male parent. All things considered this cross is very promising.

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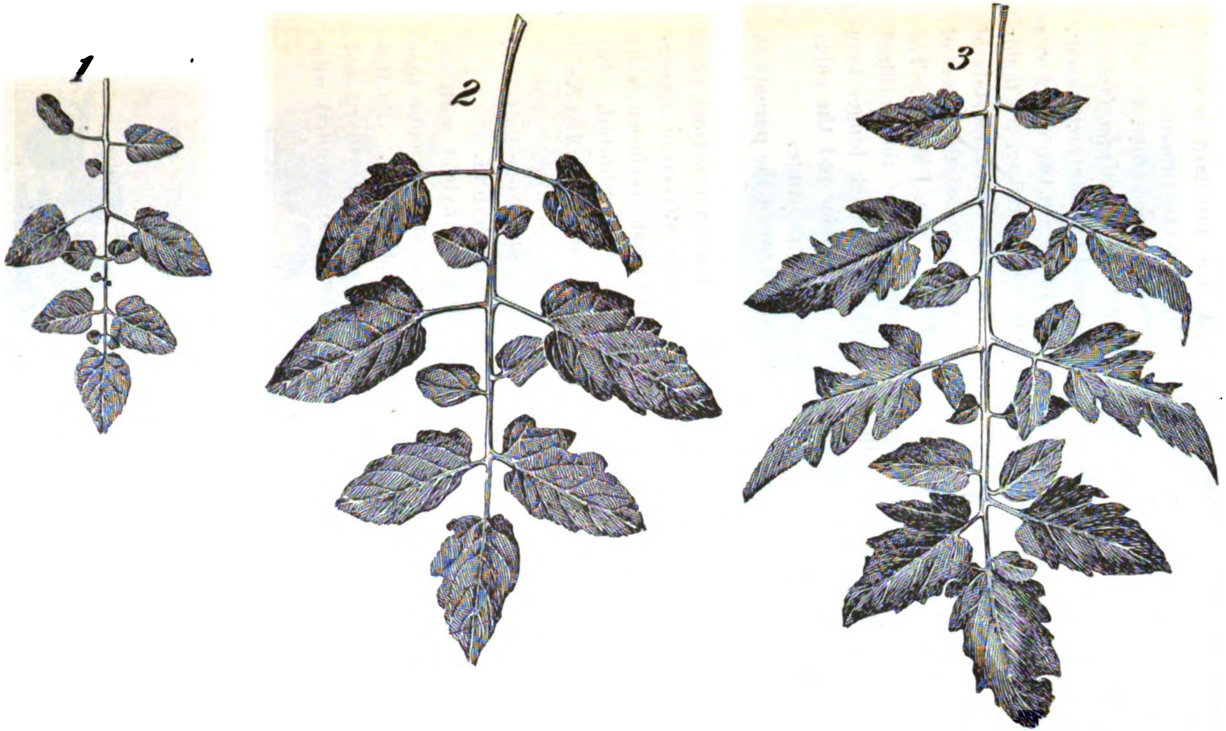
* For description of these varieties see Rep. Maine Exp. Sta. 1891, pp. 91 and 92.



1. Currant.

2. Hybrid.

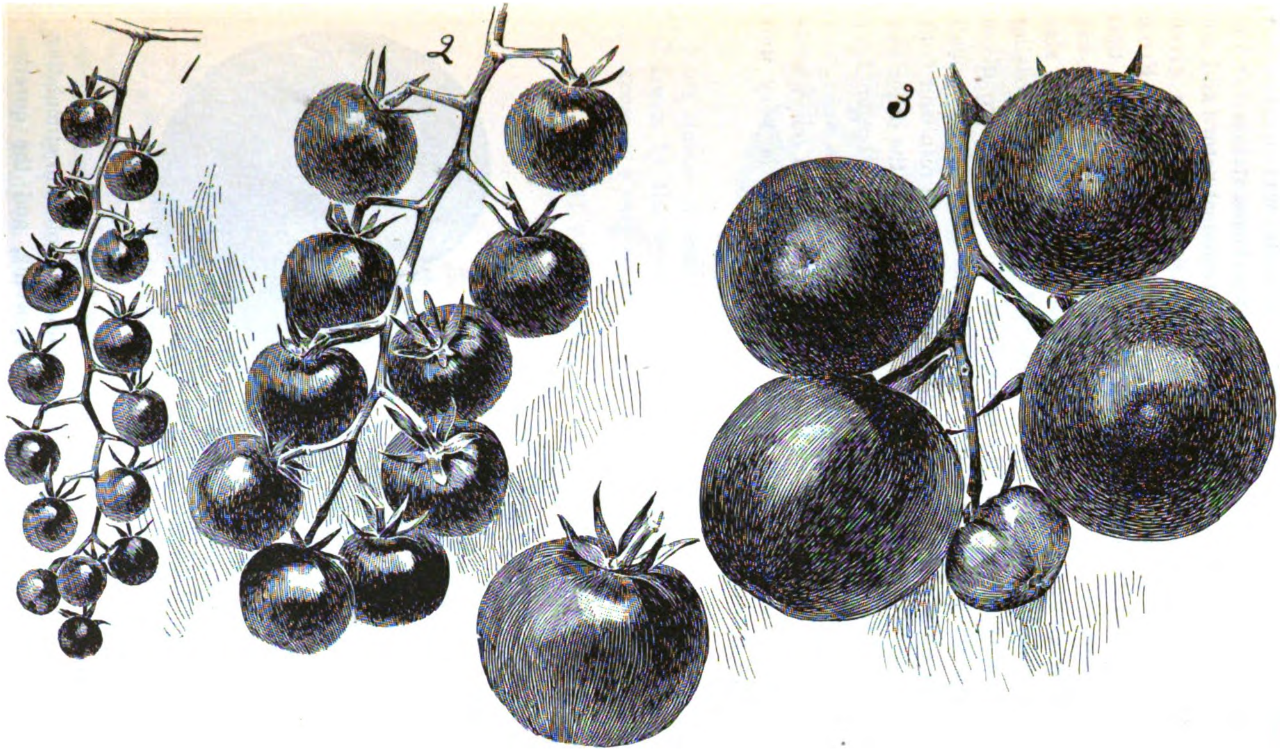
3. Lorillard.

Fig. 1 Lorillard × Currant.

Besides the crosses already named, a true hybrid was secured between the Lorillard and the Currant. The Lorillard is a well-known variety of medium size and of only moderate productiveness, belonging to the common type of *Lycopersicum esculentum*, while the Currant belongs to a distinct species—*Lycopersicum pimpinellifolium*. The Currant tomato is of weak spreading habit, with small, thin foliage and very delicate flowers, arranged in two ranks on a long raceme. These flowers, from 10 to 20 in number, are highly self-fertile and the fruit very closely resembles long clusters of cherry currants. The difference in the appearance of the leaves of the two varieties is very well shown in Fig. 1, Nos. 1 and 3. The difference in the flowers is equally marked, those of the Lorillard being somewhat conical, with the calyx lobes much longer than the petals; while those of the Currant are slender and the calyx lobes are so small the petals and stigma often protrude.

The resulting hybrids were intermediate between the parents in nearly every particular. The character of the foliage is well shown in Fig. 1, No. 2. The fruit, which from a practical point of view is most important, presented a very attractive appearance. Much of the productiveness of the Currant is shown, while the influence of the size of the Lorillard is also exhibited. The size and character of the fruit may be seen from Fig. 2. No. 1 represents the male parent—Currant; No. 3, the female—Lorillard; while No. 2 is the hybrid, all being about one-half size. The detached fruit shows the natural size of the hybrid.

Our purpose now is, by futher combining the hybrid with the Lorillard, to increase the size of the fruit, at the same time retaining if possible the prolific tendencies of the plant. To this end crosses have been made of the hybrid on the Lorillard and of the Lorillard on the hybrid and the results are awaited with interest.



1. Currant. 2. Hybrid. 3. Lorillard.

Fig. 2. Lorillard × Currant.

6. *Secondary Effects of Pollen:* This matter was discussed in Part II of the annual report of this experiment station for the present year; but as that report was of a technical nature and not printed for general distribution, some of the notes there given referring to the tomato may be repeated in this connection. From our studies of the subject of plant breeding, we have found that the amount of pollen falling on the stigma of the tomato flower may have an important bearing in determining the form and size of the resulting fruit. In the winter of 1890-1, while crossing tomatoes, two stigmas in the same cluster of flowers were given different amounts of pollen. The first was given a very small amount, while the other was given an excess. The resulting fruit from the first flower was small and deformed, while the other was of normal size and nearly symmetrical in form. The larger fruit produced an abundance of seeds and all of the cells were well developed; the smaller developed seeds on one side only, while the other side was nearly solid. This difference is very well shown in figures 3 and 4.

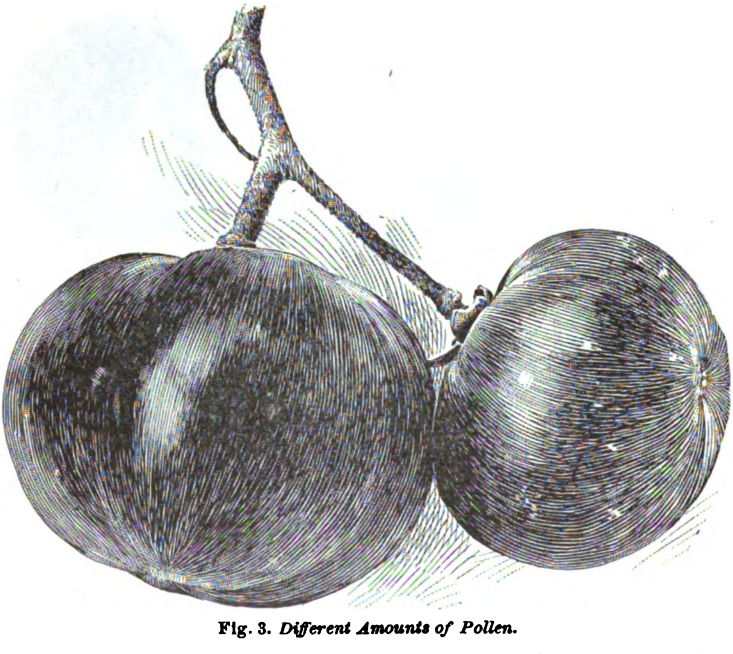


Fig. 3. *Different Amounts of Pollen.*

It is certain that the secondary action of pollen in stimulating the growth of the fruit is very important, and the question naturally arises as to what influence would be manifested on the offspring. Seeds from several of the fruits under study were sown in the house, but owing to an accident the test as to per cent. and rapidity of germination was abandoned. Several plants of each lot were grown, however, and were treated precisely alike during the season, with the results shown in the accompanying table.

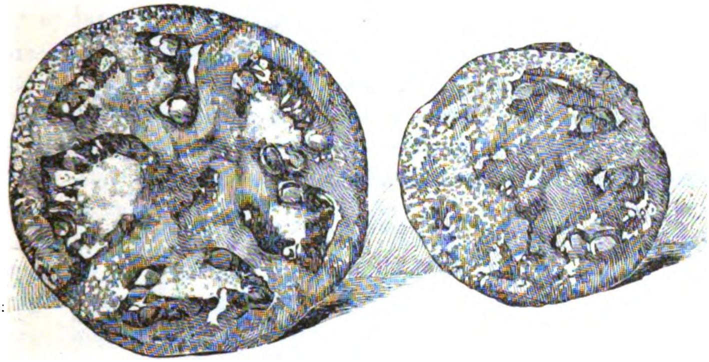


Fig. 4. *Different Amounts of Pollen.*

Each cluster of fruits is designated by a letter and the individual fruits by the word "maximum" or "minimum" according as an excess or a very small amount of pollen was employed.

TABLE V.—SECONDARY INFLUENCE OF POLLEN.

		No. of plants.	Av. No. of fruits per plant.	Av. wt. of fruit per plant. lbs.	Av. wt. of individual fruits. oz.	Date of first ripe fruit.	No. fruits ripe before Sept. 15.
A	Max	3	69	17.7	4.11	Aug. 9	23
	Min	3	68	17.3	4.09	" 8	25
B	Max	4	50	10.7	3.43	Sept. 1	21
	Min	2	27	4.6	2.74	" 5	8
C	Max	6	58	13.3	3.70	Aug. 6	38
	Min	3	70	15.3	3.49	" 12	15
E	Max	6	82	21.1	4.62	Aug. 17	20
	Min	4	74	20.0	4.32	" 18	22

As a rule, the offspring from the fruits receiving an excess of pollen were slightly the more productive and without exception the average weight of the individual fruits from these plants was greater. In general, however, the difference was but slight.

Further study on this point may throw some light on the question of the importance of the individual characteristics of a fruit in the selection of seed. We have already observed* that the character of the individual fruit is of less importance than that of the parent plant as a whole, but it also seems that the small size of the fruit, which we now believe specifically due to imperfect pollination, may be co-incident with lack of vigor, and that this lack of vigor will be apparent in the offspring to a greater or less extent.

8. *Varieties:* Among the varieties grown the past season were most of the older standard sorts and some of the more recent introductions. The accompanying table will give a comprehensive view of the comparative merits of these varieties as regards size, productiveness and earliness.

TABLE VII.—COMPARISON OF VARIETIES.

VARIETIES.	No. of plants.	No. of fruits.	Av. No. fruits per plant.	Wt. of fruit per plant. lbs.	Av. wt. of individual fruits. oz.	Date of first ripe fruit.	No. of fruits ripened before Sept. 15.
Americus Hybrid	11	131	11.9	4.74	6.4	Aug. 1.	40
Atlantic	12	194	16.2	4.20	4.2	July 29.	70
Chemin Market	12	169	14.1	3.96	4.5	Aug. 1.	59
Cleveland	11	158	14.4	6.00	6.7	" 11.	39
Early Richmond	12	201	16.7	5.65	5.0	" 3.	89
Early Ruby	12	200	16.7	5.13	4.9	July 26.	81
Essex Hybrid	11	117	10.6	3.92	5.9	Aug. 2.	35
Faultless	12	310	25.8	7.21	4.5	" 1.	93
Favorite	12	135	11.2	4.46	6.4	" 8.	39
Golden Queen	11	124	11.3	3.96	5.6	" 8.	38
Ignotum	12	161	13.4	5.87	7.0	" 1.	61
Ithaca	10	202	20.2	5.34	4.2	July 29.	82
Long Keeper	12	241	20.1	6.93	5.5	Aug. 11.	34
Lorillard	12	249	20.7	7.57	5.8	" 3.	69
Livingston's Beauty	12	164	13.7	4.95	5.8	" 9.	45
Mikado	11	170	15.5	8.00	8.3	July 25.	42
Mitchell	11	203	18.5	6.11	5.3	Aug. 3.	50
New Jersey	12	168	14.0	6.48	7.4	" 12.	31
Optimus	12	299	24.9	7.89	5.1	" 1.	98
Paragon	12	141	11.7	4.74	6.5	" 9.	38
Perfection	10	140	14.0	5.00	5.7	" 2.	41
Ponderosa	11	67	6.1	4.19	11.0	" 11.	14
Potomac	12	207	17.2	2.55	7.0	" 4.	47
Potato Leaf	11	222	20.2	7.40	5.9	" 2.	48
Prelude	12	327	27.2	3.36	2.0	July 25.	129
Red Cross	12	209	17.4	6.00	5.5	Aug. 2.	46
Stone	11	111	10.1	3.90	6.2	" 8.	25
Table Queen	12	173	14.4	6.40	7.1	" 2.	51
The Hovey	9	153	17.0	6.20	5.8	" 5.	45
Volunteer	12	226	18.8	6.73	5.7	" 5.	78
Yellow Victor	12	328	27.3	7.27	4.3	" 1.	136

The most productive varieties, in point of number, were Yellow Victor and Prelude, with an average of 27 ripe fruits per plant, before frost. Following these were Faultless with 26, and

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* Bulletin 21, Cornell University Experiment Station, page 75.

Optimus with 25; while Lorillard, Potato Leaf, Ithaca and Long Keeper ripened about 20 fruits each. Some of the larger fruited sorts produced a greater weight of fruit, but there were not as many individuals, and as a rule, medium-sized varieties are more to be desired. Prelude is very small and Optimus, with its average of 25 fruits, is far superior to it.

The date of the first ripe fruit is not an exact criterion of earliness of the crop, but in average seasons frost may be expected any time after Sept. 15, and the number of fruits ripe at that date is a safe guide, other things being equal, in selecting an early variety. The five varieties ripening the greatest number of fruits at this time were respectively, Yellow Victor, Prelude, Optimus, Faultless and Early Richmond. As will be seen, Optimus again stands third in the list and it is by far the best of the five varieties named. Of the other most productive and valuable sorts, Ithaca matured the most fruit before the date above mentioned, while Early Ruby and Volunteer came next in order.

The following field notes concerning the most important varieties were made:

Atlantic. (*Atlantic Prize*, Thorburn).—Of medium size, red, irregular, better than in 1891, but not of sufficient merit to retain.

Beauty. (*Livingston's Beauty*, Livingston).—Still a favorite pink tomato. Smooth and handsome, but not quite as productive as in former years.

Chemin. (Cornell University). Larger than in 1891 and very productive, but too late for field culture. It is one of the most profitable varieties we have under glass.

Cleveland. (*President Cleveland*, Farquhar.)—Large, smooth, red, resembling Perfection, with which it compares very favorably this year. Better than in 1891.

Faultless. (Farquhar).—Although one of the most productive varieties grown, the fruit is too irregular to be of value.

Ignotum. (Cornell University).—One of the best, but not quite so productive this year as some others.

Ithaca. (College Garden, 1891).—One of the most promising purple varieties in our collection. Is worthy the attention of seedsmen.

Long Keeper, (Thorburn).—The good impression formed last year is confirmed. It is one of the best purple tomatoes, though not quite as early as Beauty.

Mitchell. (Gregory).—Large, smooth, red; much flattened and stem set in deep basin. Ripens evenly and is productive. Much better than last season.

Optimus. (Thorburn).—Of medium size, smooth, red; productive. All things considered the most satisfactory variety in our collection this year.

Perfection. (Livingston).—Sustains its reputation as one of the best red tomatoes.

Ponderosa. (Henderson).—Very large, irregular, light purple, resembling Mikado except in foliage. Quality mild and good, but not productive. Rarely more than two or three fruits in a cluster.

Potomac. (Harris).—Large, pink, considerably flattened but not irregular. Not superior to other sorts of this class.

Potato Leaf. (Livingston).—Of medium size, smooth, pink. Plant vigorous and productive. Good.

Red Cross. (Farquhar).—Of medium size, smooth, red. Ripens evenly with little tendency to crack; but like the preceding, rather late.

Richmond. (*Early Richmond*, Landreth).—Large, red, very irregular. Not valuable.

Ruby. (Henderson).—Of medium size, red, angular. Early, but otherwise not valuable.

Stone. (Livingston).—Large, smooth, scarlet, solid. Productive, but late.

Volunteer. (Cornell University).—Of medium size, smooth, red. Plant vigorous and productive. Good.

Yellow Victor. (Gregory).—Of medium size, much flattened, inclined to be irregular. Resembles the old Large Yellow, though somewhat smoother. Of no special value.

The varieties which gave best satisfaction during the past season were: Optimus, Lorillard, Long Keeper, Ignotum, Ithaca, Perfection, Potato Leaf. Stone and Chemin Market are too late for profit. Ponderosa though exceedingly large and of good quality is too irregular and too uncertain to rank high.

Ithaca, which has never been introduced to the trade is a valuable sort worthy of dissemination.

Early Ruby and Atlantic Prize, while early, are not enough superior to other varieties in this respect to overcome the objections as to irregular form.

SUMMARY.

1. The average productiveness of tomato plants, both as regards number of fruits and weight of product, appears to be in direct proportion with the earliness of setting in the field.

2. Little or no benefit seems to be derived from the practice of bagging fruit.

3. Individual variation is such as to render conclusions drawn from a single season's work very unreliable.

4. Crossing between small fruited plants of very prolific habit and the larger fruited sorts, is a promising method of securing valuable varieties, which shall be sufficiently early for the best results.

5. Plants grown from seeds of small fruits—those receiving little pollen—were slightly inferior to those grown from large fruits from the same parent plant.

6. The best variety grown during the season, all things considered, was the Optimus.

7. Among the best varieties for general use are: *Red*, Optimus, Perfection, Ignotum, Lorillard; *Pink*, Potato Leaf, Beauty, Long Keeper; *Yellow*, Golden Queen.

8. Of the newer varieties, Cleveland, Long Keeper, Mitchell and Stone are desirable; while Richmond and Yellow Victor do not appear to be of special value.

III. Notes of Egg Plants.

The egg plant is one of the important vegetables which has as yet received little attention in this State, and the poor withered specimens sent in from other states give consumers little idea of the delicious character of this plant when fresh and well served. No doubt also, the fact that it is not common, and that cooks are not accustomed to serving it, may account to a large extent for its neglect.

The egg plant is a native of tropical America, and reaches perfection only in a warm climate and near the coast. By careful treatment, however, and by a process of acclimatization, it may be successfully grown far inland and much farther north than commonly attempted, as the successful plantings in the college gardens for the past two years abundantly prove.

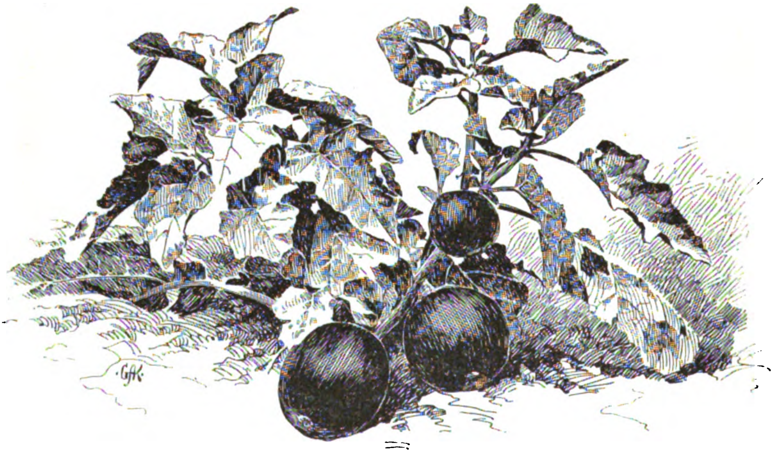

Fig. 3. *Black Pekin.*

The following notes embrace the more important results of our experiences with this plant during the past four years:

1. *Culture:* As a long season is required for the egg plant to mature, it is highly important that the plants be started early. It is our practice to sow the seeds in "flats"—shallow boxes about three inches deep—in a warm forcing house about the middle of March or the first of April. After about a month, or when the first true leaves are nicely started, the young plants are pricked off into other boxes, two inches apart each way, or, better, into 2-inch pots. About three weeks later, when the pots are well

filled with roots, or when the plants begin to crowd, the latter should be shifted to 4-inch pots. We have almost invariably had better success when the plants were handled in pots than when they were transplanted into other flats, the check caused by frequent disturbance of the roots appearing to be detrimental to most sorts. An exception is noted, however, in case of the Early Dwarf Purple which seems able to withstand very harsh treatment.

It is important that the plants be kept growing vigorously from the start, as they seldom fully recover from a check, and in order that fruit mature the plants must be strong and vigorous when planted in the field.

The plants may be set in the field, in this latitude, about June 10th to 15th. We usually set them in rows about three feet apart that they may be cultivated by horse power. The soil should be a rich sandy loam containing an abundance of organic matter. Heavy dressings of stable manure are advisable. Frequent and thorough cultivation are absolutely essential to success.

Perhaps the worst insect enemy of the egg plant is the potato beetle. The tender foliage of the young plants is specially subject to attack, and as the growth is so slow, severe injury nearly always proves fatal. Paris Green, one pound to one hundred gallons of water (about one-half teaspoonful to a large pailful of water), applied about once a week, will be found useful.

2. *Methods of Serving:* No doubt the fact that cooks are not familiar with methods of serving the fruit of the egg plant accounts to a large extent for the failure to use it more. The following recipes for cooking the fruits are given in Bulletin 26 of the Cornell University Experiment Station, and have been found satisfactory:

"1. *Fried.* Cut in slices cross-wise not over a half-inch thick and parboil about fifteen minutes; then remove and fry in a hot spider in butter and lard.

"2. *Fried.* Cut into slices ¼ to ½-inch thick and lay in strong brine for two hours; then wash *very* thoroughly; sprinkle with brown sugar, pepper and salt and fry slowly to a dark brown.

"3. *Baked.* Cut in two length-wise, remove the seeds and pulp and fill with dressing made of half teacupful bread crumbs, one teaspoonful butter, and salt and pepper to taste; lay the halves side to side in dripping pan, add a little water and bake nearly an hour.

"4. *Fritters.* Pare, cut in slices cross-wise and soak in salt water for eight or ten hours; dry on a towel, dip in beaten egg and roll in bread crumbs, then fry slowly in hot butter until the pieces become rich brown; serve hot."

3. *Varieties:* For several seasons we have grown such varieties as we could obtain from all sources. The number of varieties is comparatively limited, but there are several distinct types of varying importance. These types vary in regard to color, size, form, habit of plant and season of maturity. Some from their earliness and productivenss but small size, are valuable only for home use. Others by virtue of their large size and attractive appearance are popular in the markets, but as a rule they are not sufficiently early and productive for the short seasons of this latitude.

The following varieties have been grown in the college garden during the past two seasons and the illustrations are from photographs of plants grown here.*

Black Pekin. (Thorburn).—Plant large and vigorous; stems petioles and veins always deep purple; leaves large, more or less distinctly lobed, purple with metalic lustre above. Fruit large, 5 to 7 inches in diameter,—often larger—spherical or oblate, very dark purple. Entirely distinct from every other variety, rather late but it fruited well the past season. A popular market variety.—See fig. 3.

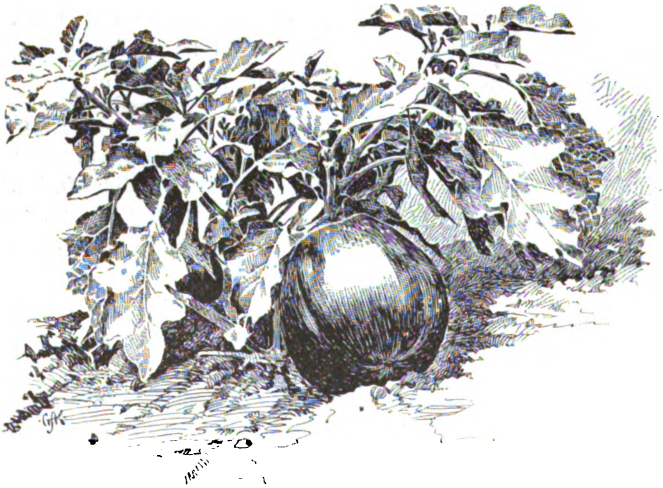

Fig. 4. *New York Improved.*

New York Improved. (Thorburn, Gregory).—Plants large and vigorous, erect; stems, petioles and veins dark green or purplish on upper surface; leaves very large, lobed, downy, with large

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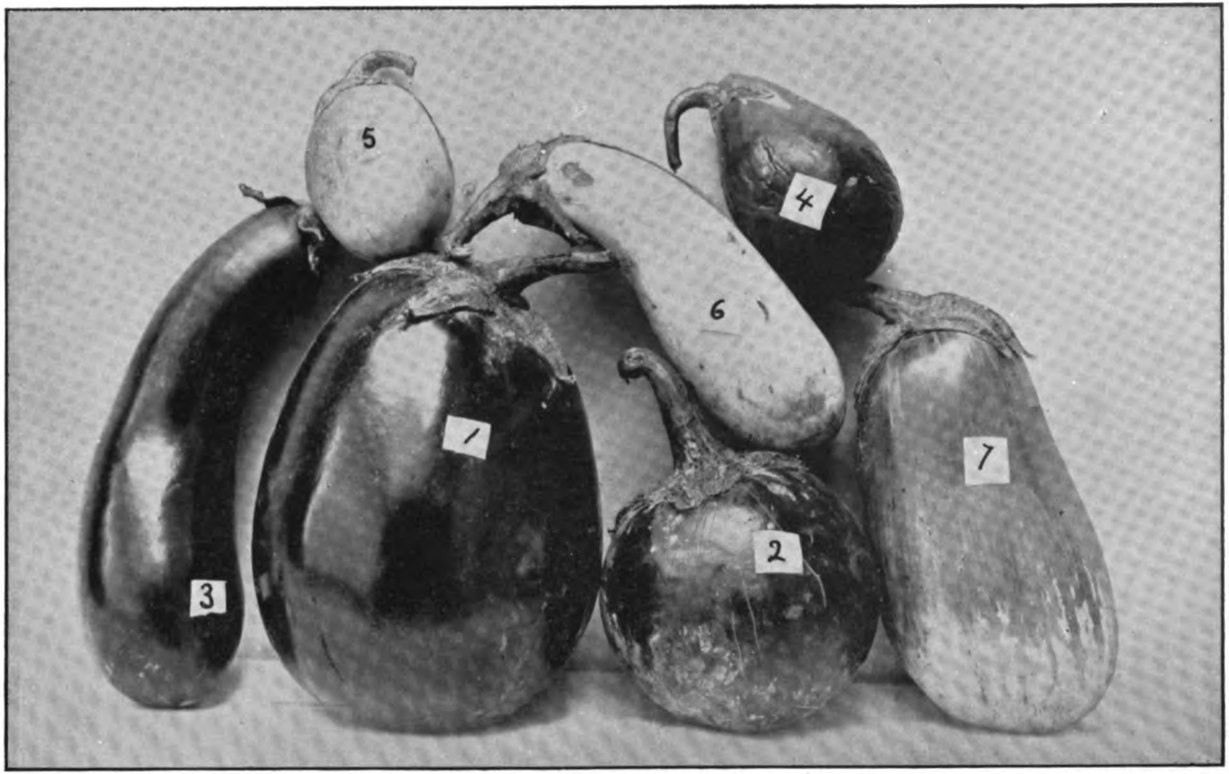
* Cuts for figures 6, 8, 9 and 10 were loaned us by the Cornell University Experiment Station.



TYPES OF EGG PLANTS See page 78.

1. New York Improved. 2. Black Pekin. 3. Long Purple. 4. Dwarf Purple. 5. Round White. 6. Long White. 7. Cross. (B 7 (*a*) p. 89.)

spines on the mid-rib. Fruit large to very large, oblong, dark purple. The most common market variety, but too late for this latitude. See fig. 4.

Round Purple. (Thorburn, Landreth).—Plant of medium size but vigorous and fairly productive. Fruit small to medium in size, spherical or oblong, pale violet. Its color renders it undesirable.

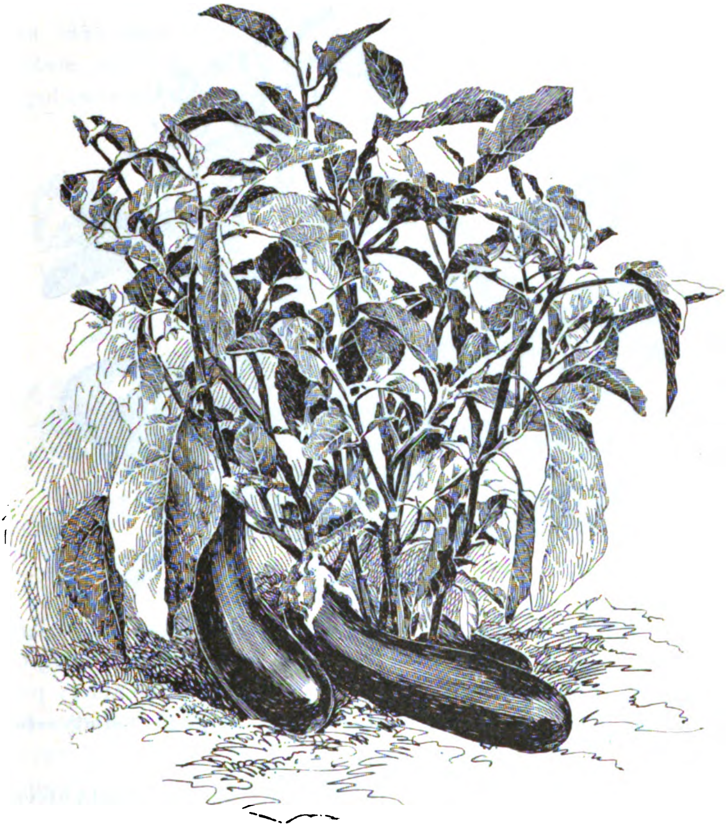


Fig. 5. *Long Purple.*

Early Long Purple. (Thorburn, Gregory).—Plant of medium size, dark green or slightly purplish; leaves medium in size, slightly lobed. Fruit long, club shaped, dark purple, of excellent quality, one of the very best for general culture. See fig. 5.

Early Dwarf Purple. (Gregory).—Plant, low, weak, spreading, spineless; stems and petioles dark purple, slightly downy, leaves small, dark green with purplish tinge. Fruit small—three to six inches long—pyriform, dark purple. The earliest and most productive variety grown; hence perhaps the most valuable for home use. It is too small, however for a market sort. We have found this sort better able to overcome the effects of neglect than any other variety grown, and plants started in a hot bed as late as the first of May have given excellent results. Fig. 6.

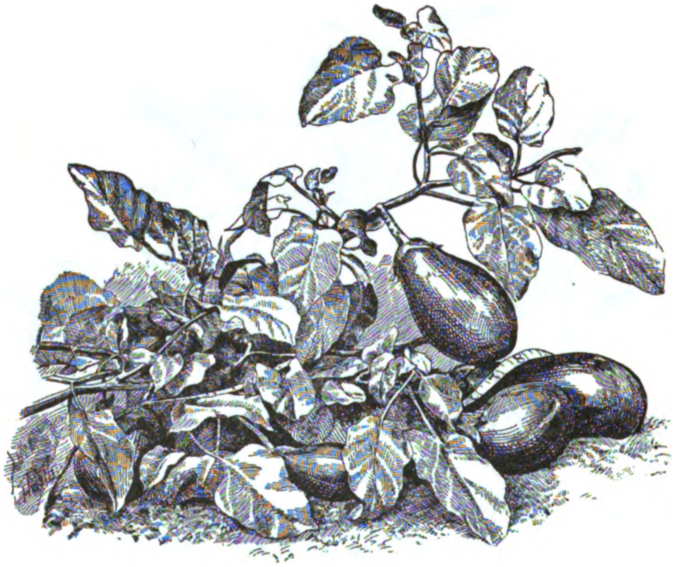


Fig. 6. *Early Dwarf Purple.*

Long White. (Thorburn).—Plant of medium size, erect, light green, downy; leaves of medium size with undulate margins. Fruit long, frequently curved, abruptly rounded at the apex; pure white, becoming yellowish at maturity. A good variety—See fig. 7.

Round White. (Thorburn).—Plant small, upright, bright green; stems, and petioles smooth and shining under a slight covering of down. Fruit small—rarely four inches long—egg shaped, white and like the preceding yellowish, at maturity, very prolific and early, but hard and tough rendering it scarcely edible. Valuable only as an ornament. See fig. 8.

Striped on Guadeloup. (Thorburn).—Plant vigorous, erect, resembling that of Long White. Fruit oblong,—three to five inches long—white with purple longitudinal stripes. Exceedingly prolific, but valuable only for ornament.

4. *Experiences in Crossing*: Our studies of this subject began in 1889, when several crosses were made with the specific purpose of producing new types combining the most valuable features of existing varieties. Some of the earlier results were published in a bulletin from the Connell University, in 1891;* but it will be necessary to repeat some of the statements there made in the present connection.

In 1889 three distinct series of crosses were made. The first of them, which we called *Series A*, was the Round White crossed by pollen from Black Pekin (see figures 8 and 3). These varieties represent two widely different types, and it was hoped we could combine the earliness and productiveness of the former with the beauty of form and color and the excellent quality of the latter.

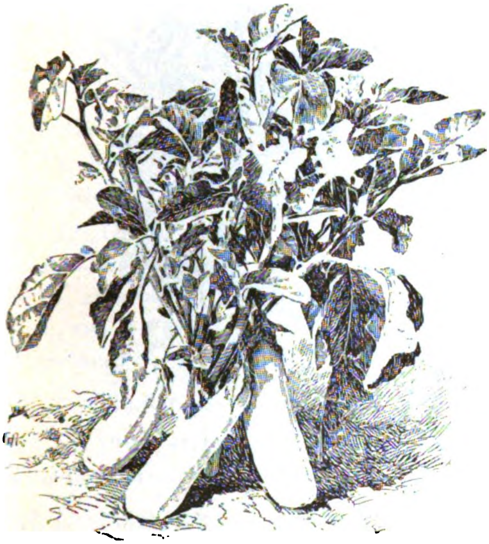


Fig. 7. *Long White.*

In the second cross, which we called *Series B*, Giant Round Purple was crossed with pollen from White Chinese. The first of these—figure 9, differs little from New York Purple except in size of fruit which is very large. White Chinese differs little in habit from Long White described on page 80, but the fruits are slightly larger and usually curved, (see figure 10). It is a very handsome variety. These two sorts have not been grown in Maine.

In the third cross, *Series C.*, Long White was crossed with Black Pekin. Long White in this case differed from the sort described under that name on page 80, in that the fruit was shorter, being somewhat ovoid in form, while the color was greenish white.

The seeds resulting from all of the above crosses were sown in 1890, and the plants were given conditions as nearly uniform as possible. The plants proved quite variable, and crosses and selections were made in the hope of fixing the more valuable types. Seeds of some of the best of these were brought by the writer to Maine, and were planted in 1891.

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* Bailey & Munson, Bul. 26, Cornell Univ. Exp. Sta., March, 1891.

Following, is a somewhat general account of the results obtained with each series:

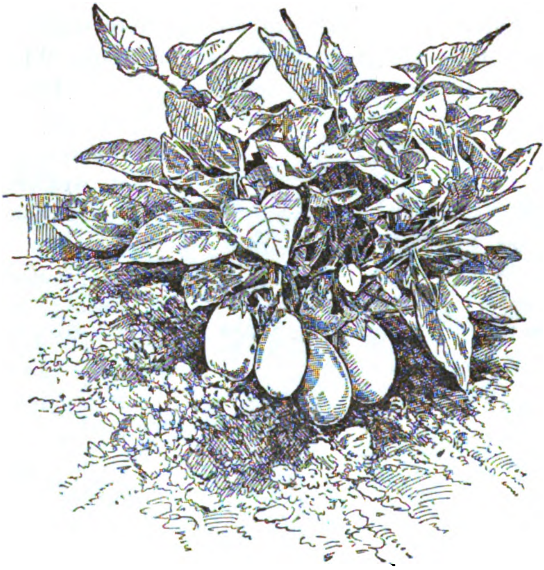

Fig. 8. *Round White.*

Series A.

Round White X *Black Pekin.*—One fruit, the result of the first cross, gave in 1890 a series of plants intermediate in general character, between the parents. The young shoots were much like the pistillate parent,—Round White—but as they became older, the upper surface of the stems, the petioles and the veins of the leaves became of the purplish color of the male parent. In form and size, most of the fruits varied in the direction of the pistillate parent. Some were larger, however, and frequently the same plant would bear mature fruits two inches and others five inches in diameter. In color, the fruits were purple while young—usually dark purple with lighter apex. Occasionally this color was retained till time of edible maturity, but as a rule, the dark purple became of a dull greenish cast, while the apex became metallic gray with streaks of grayish purple extending towards the base.

From this first generation, several crosses and selections were made for further study. These were as follows:

A 1. Given pollen from another flower of same plant.
A 2. Given pollen from Round White (female parent).
A 3. Given pollen from Black Pekin (male parent).
A 4. Same as A. 3.
A 5. Same as A. 1.
A 6. Same as A. 1.
A 7. Same as A 2.
A 8. Selection, parentage uncertain.

Of the above selections the fruit was uniformly of the color before described, but varied considerably in size. The general characteristics of the plants were as follows:

A 1. Of the general habit of Round White,—the pistillate parent—but the upper surface of stems, petioles and veins was purple, showing influence of the male parent. Of the four fruits borne, two were the size of a hen's egg, and two much larger—6 inches long.

A 2. Similar to the first, but the purplish tinge less marked.

A 3. Plant strong and vigorous, with upper surface of stems and leaves dark purple.

A 4. Plant vigorous, leaves much larger than with the first three, many of them being considerably lobed, and all of the pronounced purplish cast of Black Pekin. The fruits, however, were shaped like Round White.

A 5. Plant of medium size, bright green. Two fruits of medium size—about six inches long—mostly of two shades of purple, with upper surface dark green. Very mature fruit has yellowish cast of Round White.

A 6. Very similar to A 5.

A 7. Plant of the general type of the series. Fruits of three distinct forms, one like Round White, a second four inches in diameter and like Black Pekin, the third spherical and very small.

As an example of variability induced by crossing, this series is one of great interest. There were no immediate effects of pollen, but we find in the first generation marked indications of the influence of both parents—the habit of the plant and the size of the fruit resembling the female, while the color of the male is apparent.

None of the products of this series promised to be of any commercial value, however, and they were not considered by the writer after leaving Cornell. All of the seeds from each of the individuals treated as indicated on page 84 were sown by Professor Bailey, in 1891, and his comments on the behavior of the resulting plants, as published in a recent bulletin,* are here given:

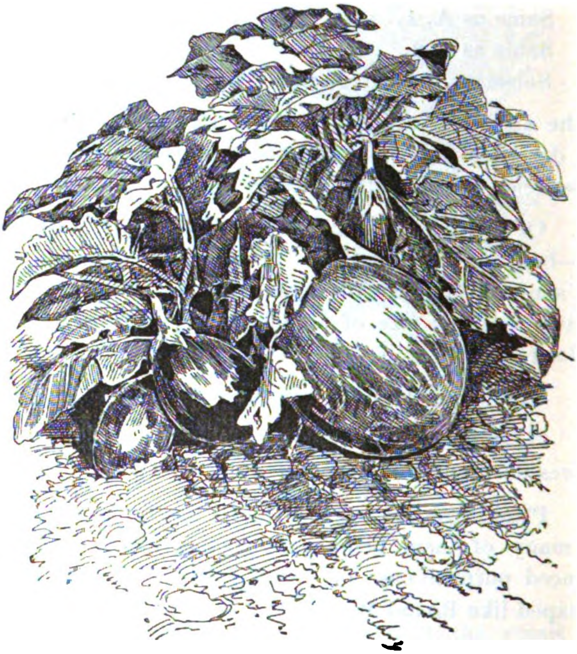

Fig. 9. *Giant Purple.*

"It is interesting to note the influence of Black Pekin in A. 3 and A. 4, into which this variety has twice entered as a staminate parent. All the plants 203, in number, were purple in foliage and like Black Pekin in habit; and most of the fruits were solid purple, although a few striped fruits still showed the influence of the Round White two generations back. The ones into which the Round White entered twice—A. 2 and A. 7—do not show so strongly the marks of the double infusion of blood. In A. 2, there are a few more plants with green, than with purple herbage, and the green ones were more productive than the others; these are marks of the Round White, and it may also be said that even the purple plants were of a light cast, and that nearly all showed the influence of the dwarf habit of Round White. A. 7 the other Round White Cross, produced a lot of small plants, but they were unproductive and much over half of them had purple herbage."

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* Bulletin 49, Cornell University Experiment Station, Dec. 1892.

A 1, A 5 and A 6, pollinated from another flower of the same plant were exceedingly variable. "In fact A 1 was probably the most hopelessly mixed of any in the entire list. The fruits ranged from pure white to green with white stripes, purple striped, light solid purple, and very dark purple; and the mature fruits varied from the size of an egg to that of Black Pekin. About equal numbers of the 175 plants were green and purple. A 5 was nearly as badly mixed, and some plants appeared which had the peculiar spreading habit of Early Dwarf Purple, a variety which had never entered any of the crosses. A 6 showed wide variations also. A 8, which was simply a selection and had not been artificially pollinated, was about as variable as the rest."

It will thus be seen by comparing the characteristics of the plants of the two generations that crossing with either parent served merely to intensify tendencies already existing, and that the use of pollen from another flower of the same plant was apparently ineffectual in serving to "fix" any type.

SERIES B.

Giant Round Purple X *White Chinese.*—This cross resulted in some of the most promising types I have ever grown. The plants, as in series A, were as a rule intermediate in habit and character between the parents. The sturdy, vigorous habit of Giant Purple, the female parent, was exhibited, but the leaves were smaller and less distinctly lobed than in that variety.

In form the fruits, as a rule, resembled the male parent, White Chinese, but they were of greater diameter. The color at edible maturity was rich dark purple with lighter apex. When left for seeds to ripen, the dark purple body of the fruit became of a dull greenish hue, while the lighter apex became gray, then yellowish like the male parent.

As in the first series, a number of individuals were again crossed with the original parents and some of the more promising types were selected without artificial pollination. All of these crosses and selections were grown by Professor Bailey at Cornell University,* and some of those appearing most valuable were brought by the writer to Maine.

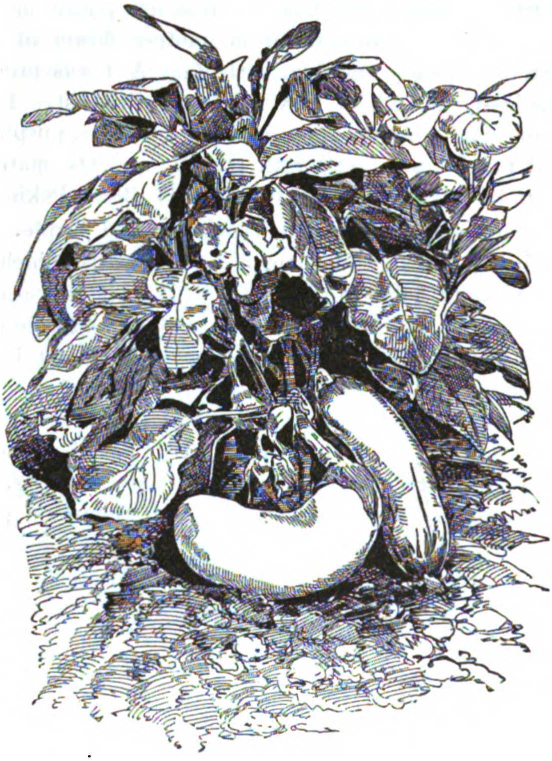

Fig. 10. *White Chinese.*

The parentage of those grown at this station was as follows:

B 1. Crossed by Giant Purple (female parent).

B 2. Pollinated by another flower from same plant.

B 3. Crossed by Giant Purple.

B 5. Crossed by Giant Purple, as in B 1 and B 3.

B 7. Selection, not artificially pollinated.

In every instance these parent fruits were of the general form and color above described. The offspring, however, were exceedingly variable. The plants were of the intermediate type, characterizing those of the first generation, but in the fruits wide differences were noted. B 1 into which Giant Purple has twice entered—first as pistillate, then as staminate parent—still showed the effect of White Chinese in two out of the eight plants grown. As a rule the fruits were dark purple and of greater diameter than the immediate parent, but one fruit while of the form of Giant Purple had the light apex and streaks of the immediate parent, while another was very light purple with green apex and stripes even when very immature.

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* See Bulletin 49 Cornell Univ. Exp. Sta., Dec., 1892.

B 2 which contained no fresh admixture of either parent, showed a marked tendency to revert to the light form. With three exceptions the fruits were much lighter colored than the parent. Two plants bore fruits of a dark green ground color with apex nearly white and dotted and splashed with purple; while another bore very light green fruit with splashes of purple fading to a yellowish green at maturity.

B 3 showed very plainly the double influence of Giant Purple. In no case was the immediate parent perpetuated. The plants were exceedingly vigorous; leaves large, considerably lobed. Fruit ovate—about 6 inches long and 4 inches in diameter—very dark purple, almost black. Two plants bore fruit with lighter apex, but the very light forms seen in B 1 were not present.

B 5 very closely resembled B 3 in form and color but with greater tendency to light apex. The fruits were very handsome—often 9 inches long and 4 inches in diameter. B 7 was exceedingly variable both in form and color—the latter ranging from very dark purple through all gradations to light green with white apex and no trace of purple.

Selections from all of the above types were again made, but most of the fruits failed to ripen and were lost. Those saved were grown the past season and gave the following results: B 1 (a)—a selection from B 1, bearing purple fruits shaped like Giant Purple—retained the form of its immediate parent but was exceedingly variable as to color, many of the fruits being dull green with white apex and stripes, others irregularly splashed and mottled with purple. B 5 (a) also showed a marked tendency to revert to the white form. The parent was in no case perpetuated and no valuable form appeared. B 7 (a)—selected from the light type of B 7 in 1891—in no case gave a suggestion of the purple color of the Giant Purple. The form was oblong-pyriform, about 3 1-2 by 6 inches. Aside from the very small sorts this selection was

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the most prolific sort grown, but its color would condemn it as a market sort. A specimen of this type is shown as No. 7 in the frontis-piece.

SERIES C.

Long White X *Black Pekin.*—In 1890, the first generation, the effect of the staminate parent was very marked in giving color to the foliage, much more so than was the case in series A in which the male parent was also Black Pekin. The plants were uniformly tinged with purple, and in some instances the color was nearly as dark as in the male parent. The fruit was of intermediate color with the purple predominating, but in form was quite variable. Some individuals resembled the staminate parent, other the pistillate, and others were entirely distinct.

This was the least promising of the series and though four fruits were again crossed or selected, but one, C 4, was brought by the writer to Maine. Of the others, grown at the Cornell Experiment Station in 1891. Professor Bailey reports: "In these lots the fruit pollinated from the same plant, C 1, gave a variable and very unproductive offspring. C 3, into which Black Pekin has gone twice gave only purple fruits."*

C 4 was not artificially pollinated, but was selected because of its excellent form, being almost cylindrical with very abruptly rounded ends. Seeds were sown in 1891 and of the resulting plants only two showed a tendency to perpetuate the type of C 4, and these failed to mature fruit. There was a variation in the direction of both of the original parents but in general the plants were of the type of the previous generation.

Selections were again made, and in 1892, there was almost complete reversion to the original male parent in the habit and color of the plants. They were hardly distinguishable from the plants of Black Pekin in adjacent rows. The form of the fruit, however, was still quite variable.

Conclusions as to Effects of Crossing: As a result of four years of breeding, we have as yet obtained no type sufficiently constant in color to be of commercial value. We have found, however, a marked increase in vigor and productiveness as a result of crossing.

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* Bulletin 49 Cornell Univ. Exp. Sta., Dec., 1892, p. 344.

In the first generation the purple-fruited types seem stronger in their power to transmit color to the offspring than do the white-fruited types; and this law appears to hold whether the purple type is used as the male or as the female parent. In later generations the inherent strength of the white-fruited types appears more strongly than in the first; for in the third generation, after the purple type had twice entered the cross, the effect of the original white parent in imparting color to the fruits was more marked than in the first generation.

In all cases the white-fruited types appear stronger in the power to transmit form and productiveness.

SUMMARY.

1. With careful treatment the egg plant may be successfully grown in Maine. The most important requisites of success are: Early sowing; vigorous plants; late transplanting to the field; warm, rich soil; thorough cultivation; constant watchfulness for the potato beetle.

2. The best varieties for this latitude are Early Dwarf Purple, Early Long Purple, Long White, and possibly Black Pekin. Other large varieties are too late.

3 The chief advantage derived from the crossing of the different races of egg fruits appears to be in the increased vigor and productiveness of the offspring. No valuable market sorts have as yet been developed.

FRUIT TESTS.

The winter of 1891-2, was very mild and little injury was done in the fruit plantations. All varieties made a good growth during the season, and as far as practicable the vacancies in the orchard, caused by the previous severe winter, were filled. Several additional varieties of pears, also of cherries were obtained, and a plum orchard has been established. The small fruit plantation has also been largely increased in extent.

The fruit plantations are now systematized, and maps and well defined forms for records have been constructed, thus rendering the plantations more valuable, for purposes of study and avoiding danger of confusion.

The additions to the experimental orchards and small fruit gardens the past season consist of the following:

Apples 5 varieties; pears 8 varieties; plums 13 varieties; blackberries 2; currants 3; dewberries 1; gooseberries 2; raspberries 11; strawberries 14.

With the exception of a few varieties of raspberries and blackberries, there is as yet no basis for a comparison of the merits of different varieties for this region. As soon as the various sorts come into bearing, more detailed reports may be made for the benefit of planters.

The work of securing valuable sorts that will stand the trying climate of the northern part of the state is being continued on an extended scale. During the past season cions of the following varieties have been sent to Perham, Aroostook Co.: Arthur, Borst, Duchess Seedlings number 4 and number 8, North Star, Patten's Greening from C. G. Patten, Charles City, Iowa; Daisy, Gideon number 6, Malinda, McMahon, Okobena, Ostrakoff, Patten's Greening and Utter from J. S. Harris, LaCrescent, Minnesota; Hibernal, Korsk Annis, Red Queen, Repka from Wm. Somerville Viola, Minnesota; Palouse from Geo. Ruedy Colfax, Wash; Rolfe, Maine State College.

Besides the above named cions, two year old trees of the following varieties were kindly donated by the Jewell Nursery Co. of Lake City, Minn. Thompson's seedlings numbers 24, 26, 29, and 43. As was the case last season part of these cions were set in bearing trees and part in seedling stock raised from Duchess seed.

The season was a favorable one for young stock, and all varieties made a vigorous healthy growth. None of them were taken up in the fall, and as the present winter is a very severe one with little snow, the test as to hardiness will be a crucial one.

The following varieties of Russian plums, purchased from the Iowa Agricultural College in 1891, were also placed on trial the present season: Bessarabian, Early Red, Hungarian Prune, Moldavka, Orel Sweet, Varonesch Yellow, White Nicholas, Nos. 19, 20 and 23 Orel; besides these one tree each of Cheney, Wolf and and Wyant from the same source and Rollingstone from O. M. Lord, Minnesota City, Minn. All of these last named sorts are valuable varieties of the hardy native *Prunus Americana*, originating in the trying climate of the northwest. It is our purpose to increase the list of plums next season and if possible by crossing some of these very hardy sorts with others of higher quality secure desirable sorts which shall rank with Moore's Arctic as a profitable variety for this region and possibly shall not require the winter protection demanded by that variety.

There is little doubt that with proper management small fruits might be made even more profitable in the northern parts of the State than in the southern, as at this latitude the crop ripens so late as to escape more southern competition. With this end in view, a number of varieties are being introduced. Some are already grown at Houlton—notably the Houghton gooseberry and the Agawam blackberry, but so far as I can ascertain little is being done even in the home gardens of northern Maine toward raising other small fruits.

Last spring plants of Windom and Lucretia Dewberry and of North Star Currant were sent to Perham for trial. Others will be sent later.

At the present time an effort is being made to determine the exact status of the fruit industry in the State, especially in the more southern portions, that we may have a basis for intelligent work in developing this line of work. A report on this subject will be published during the ensuing year.

SPRAYING EXPERIMENTS.

The work of spraying to prevent the attack of the apple scab was continued on the same line as last year, both Mr. C. S. Pope of Manchester and Mr. C. E. Moore of Winthrop, co-operating. The season was very unfavorable and it was difficult to find a suitable time for the work. In nearly every instance rain fell within twenty-four hours after the spraying was completed. As a result, the effects of the fungicides were somewhat modified and were less striking than those obtained last year.

Results in Mr. Pope's Orchard.

In Mr. Pope's orchard the work was of sufficient extent to warrant very free conclusions from a commercial point of view. The orchard is situated on a gravelly hill-side having a northwestern exposure and has been very subject to the attack of the fungus for some time.

The main object in view in this work was to determine the relative values of different solutions and to study the effects of applying the mixture at different times.

To this end, instead of single trees, given different treatment, contiguous rows extending down the hill-side were selected. In this way all rows presented essentially the same conditions, part of the trees being on high land and part on low. This matter of location is of the highest import since it has been observed—in this orchard and some others I have studied—that trees on high exposed situations are apparently more subject to attack than are those on lower ground.

Three solutions were used in the test as follows:

Solution A. Modified *eau celeste*, consisting of two pounds copper sulphate, two and one-half pounds carbonate of soda, one and one-half pints ammonia and thirty gallons water.

Solution B. Five ounces carbonate of copper, three pints strong ammonia, fifty gallons water.

Solution C. Three ounces carbonate of copper, one pound carbonate of ammonia, fifty gallons water.*

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* For directions as to preparation of mixtures see Rep. Maine Ex. Sta., 1891, p. 116.

To be doubly sure of results, duplicate series were used. In this way we have two rows in different parts of the orchard sprayed with each solution; while for comparison three rows alternating with these were left without treatment. Naturally all of the trees were not equally productive, and in counting the fruit only those trees which were under approximately the same conditions were selected.

Because of the large number of trees to examine it was impossible to count all of the fruit from each tree, hence five basketfulls, or two and one-half bushels were taken from all parts of each tree.

Table VIII gives the results obtained from the first series, and table IX those from the second.

TABLE VIII.

Solution.	Average number fruits examined.	Free from scab.	Slightly scabbed.	Badly scabbed.	Per cent. free.	Per cent. No. 1 apples (as regards scab).	Remarks.
"A".......	563	219	332	14	39.00	97.6	Average of four trees.
Check.............	681	0.6	203	477	0.09	30.1	" " five "
"B"...............	550	47	410	93	8.50	83.7	" " " "
"C"...............	663	24	429	209	3.73	68.6	" " " "
Check.............	633	0.6	207	425	0.12	35.5	" " " "

TABLE IX.

Solution.	Average number fruits examined.	Free from scab.	Slightly scabbed.	Badly scabbed.	Per cent. free.	Per cent. No. 1 apples (as regards scab).	Remarks.
Check.............	633	0.6	207	425	0.12	35.5	Average of five trees.
"A".......	552	123	361	67	23.6	88.3	" " four "
"B"...............	637	12	290	336	2.1	49.8	" " three "
Check.............	556	17	324	215	3.1	62.1	" " four "
"C".......	535	46	388	101	8.9	81.7	" " three "

The superiority of the fruit on trees treated with solution *A*—modified *eau celeste*—is seen at a glance; while solutions B and C do not appear widely different. With a single exception the average increase of marketable fruit as a result of the treatment ranges from 19 to 60 per cent. Row "B" in table IX was a short row and contained one tree which was very badly attacked—only 27.6 per cent. of the fruit being "No. 1"—thus bringing the average below that of the adjoining check row, which was better than the average.

Combining the results obtained in the duplicate trials, these facts stand out even more clearly, as seen in table X.

Table X.

Solution.	No. examined. Average per tree.	Free from scab. (Average).	Slightly scabbed. (Average).	Badly scabbed. (Average).	Per cent. free. (Average).	Per cent No. 1 apples (as regards scab). (Average).	Remarks.
"A"……. ….	559	171	347	41	30·1	93·0	Average of 8 trees.
"B"…………	583	34	365	184	6·1	71·0	" " " "
Check……….	615	32	414	169	5·6	73·5	" " " "
"C"…………	628	5	239	384	0·93	41·2	" " 14 "

As will be observed, the average proportion of "No. 1" fruit on unsprayed trees—considering fourteen trees in all parts of the orchard—was only 41.2 per cent. of the crop; while the average proportion on trees sprayed with the least effective solution was 71 per cent., a gain of nearly 30 per cent. With the modified *eau celeste* this difference was much more marked, amounting to nearly 52 per cent., or a saving of more than half of the total crop.

The amount of fruit absolutely free from scab is not as large as might be wished; but the standard adopted in sorting the fruit was very rigid, and much of that classed as "slightly scabbed" was in reality better fruit than that classed as "free." It was observed, however, that fruit from the trees sprayed with *eau celeste* were frequently russetted, as though the solution was too strong.

With these figures in view, and considering the fact that the results are in direct confirmation of those obtained last year, there would appear to be little doubt as to the effectiveness of the treatment when the work is properly conducted.

The value of duplicating any experiment of this kind is well shown by comparing tables VIII and IX. Table VIII gives data which would apparently warrant drawing very positive conclusions as to the relative merits of the different solutions; while table IX would appear to reverse the relative positions of solutions "B" and "C," and even indicates that solution "B" is of little if any value. But by combining the data we approximate nearly the true results.

When Shall we Spray? A part of the work in Mr. Pope's orchard was conducted with a view to determining the best time for applying fungicides, as well as the relative value of several applications. To this end some trees were sprayed but once, early in the season; others were sprayed twice, some three times and some four times; while some trees were not sprayed. Solution "B" was used in every instance.

The results of this trial are shown in table XI.

TABLE XI.

No. times sprayed.	Number fruits examined.	Free from scab.	Slightly scabbed.	Badly scabbed.	Per cent. free.	Per cent. No. 1 apples (as regards scab).	When sprayed.
Once....................	499	13	314	172	2.6	65·6	May 26.
	497	1	161	335	0.2	32·6	
	481	12	301	168	2.5	65·1	
	604	0	212	392	0.0	35·1	
	600	4	267	329	0.7	45·2	
Average per tree..	**536**	**6**	**251**	**279**	**1·2**	**48·7**	
Twice................	688	0	287	401	0.0	41·7	May 26, June 23.
	610	2	314	294	0.3	51·8	
	542	26	355	161	4.8	70·3	
	556	0	237	319	0.0	42·6	
Average per tree..	**599**	**7**	**298**	**294**	**1·3**	**51·6**	
Three times..........	583	30	439	114	5.1	80·3	May 26, June 23. July 21.
	617	38	455	124	6·2	79·9	
	684	27	432	225	3.9	67·1	
	485	36	360	89	7.4	81·6	
Average per tree..	**592**	**33**	**421**	**138**	**5·6**	**77·2**	
Four times...........	588	21	346	221	3·6	62·4	May 26, June 23, July 21, Aug. 20.
	438	45	292	101	10.3	76·9	
	552	18	372	162	3.2	70·6	
Average per tree..	**526**	**28**	**337**	**161**	**5·7**	**70·0**	
Three times..........	559	6	315	238	1.1	57·4	June 23, July 21. Aug. 20.
	707	7	285	415	1.0	41·3	
	462	25	300	137	5.4	70·3	
Average per tree..	**576**	**13**	**300**	**263**	**2·5**	**56·3**	

There is a very noticeable difference in the percentage of good fruits on adjacent trees when treated in the same manner. But trees sprayed three or four times are more uniformly good than those sprayed once or twice. As seen in the table, in the row sprayed once, there is a difference of more than 32 per cent. in the amount of fruit on the second tree, and that on the trees on either side—a difference frequently noted on the unsprayed rows. In the rows treated twice this difference is not quite so marked; while in the rows sprayed three or four times the greatest difference is only about 14 per cent., the lowest percentage being nearly equal to the highest on the trees sprayed but once.

By comparing the last division of the table with the third, it will be observed though each row was sprayed three times the average quality of the fruit is much lower in the former case, the average per cent. of No. 1 fruit being 56.3, as opposed to 77.2 in the third row. That is, the indications point strongly to the value of spraying *early*. The two rows in question were under essentially the same conditions, being parallel and separated by only one row, which was sprayed four times, but the first was sprayed once before the blossoms opened, while the other was not sprayed till June 23.

The results obtained are not conclusive, but in general they point to the value of repeated applications and to the desirability of spraying early in the season.

Results in Mr. Moore's Orchard.

To check our work still further, arrangements were made with Mr. C. E. Moore of Winthrop to continue the work of the previous year in this direction. Mr. Moore's orchard is usually very badly attacked, and would seem to be an excellent field for work. The trees bore very heavily in 1891, however, and were not as well adapted for our use as they otherwise would have been. Those trees which bore but little fruit are not considered in compiling the tables, as such trees are seldom attacked so severely as are those which bear a full crop. As will be observed, the character of the fruit on the different trees is very unequal; that on some trees being either excessively scabby or remarkably free from scab, while that on other adjacent trees may represent the opposite extreme. Thus it follows that the average percentages as given in the tables do not always represent the true average condition of the trees, especially is this the case when a larger number than common is taken from any one tree. As before noted, however,

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the amount of fruit was so variable, that in order to get proportionate quantities from the different classes, it was impossible to adopt an inflexible rule as in the first orchard considered.

But two solutions were used in Mr. Moore's orchard viz: Solutions "B" and "C" described on page 92.

In comparing the two solutions a number of trees were sprayed four times each, on May 26, June 15, July 15, and Aug. 15, or as near these dates as possible. Rain followed soon after each application, and the results are not striking, as seen by table XII.

TABLE XII.

Treatment.	Number fruits examined.	Free from scab.	Slightly scabbed.	Badly scabbed.	Worthless.	Per cent. free.	Per cent. No. 1 apples (as regards scab.)	Remarks.
Solution "B"....	1892	8	829	797	348	0.4	42.2	Always one of the worst in the orchard. Very full; fruit small; ½ of whole counted.
Sprayed 4 times.	839	188	498	183	25	16.4	75.2	All the fruit taken. Opposite Check No. 8.
	456	28	359	61	8	6.1	84.9	All the fruit.
Average..........	**1092**	**58**	**560**	**347**	**127**	**5.3**	**56.6**	
Checks....	577	9	318	227	23	1.6	56.7	Small tree; light crop.
	2334	6	1175	927	226	0.3	56.0	All the fruit counted; opposite No. 1, solution *B*.
	1006	0	415	565	26	0.0	41.2	½ of all counted.
Average..........	**1306**	**5**	**636**	**573**	**93**	**0.4**	**49.1**	
Solution "C"....	522	6	246	224	46	1.1	48.3	All the fruit.
Sprayed 4 times.	854	24	415	382	33	2.8	51.4	½ of all.
	1047	20	542	469	16	1.9	53.7	½ of all.
Average..........	**808**	**17**	**401**	**358**	**32**	**2 1**	**51.7**	

As will be observed the average results are slightly in favor of the sprayed trees as compared with the unsprayed, while solution B gave slightly better results than did solution C, the average increase in No. 1 fruit being 5.5 per cent. in the former case and 2.6 per cent. in the latter. The percentage of fruit absolutely free from scab is very low in every instance, but in a general way the work has some value in that it confirms the results obtained in Mr. Pope's orchard.

Number of Applications.

Some of the trees in Mr. Moore's orchard were sprayed twice with solution B, and others three times, while others in close proximity were left as checks. Trees sprayed four times were under somewhat different conditions and can not be compared with these.

Table XIII shows the results obtained from this trial.

TABLE XIII.

No. times sprayed.	Number fruits examined.	Free from scab.	Slightly scabbed.	Badly scabbed.	Worthless.	Per cent. free.	Per cent. No. 1 apples (as regards scab).	Remarks.
Twice…………	696	28	452	195	21	4.0	68.9	All the fruit counted.
	917	35	620	252	10	3.8	71.4	About ½ the fruit. Adjacent to first tree sprayed three times.
	529	231	278	30	00	42.9	94.5	All the fruit.
Average…………	**717**	**98**	**450**	**159**	**10**	**13.7**	**76.4**	
Three times…….	833	73	574	168	18	8.8	77.7	All the fruit.
	787	78	491	206	12	9.9	72.8	⅓ of all; very good.
	970	55	764	151	00	5.7	84.4	About half; small.
Average…………	**868**	**69**	**610**	**175**	**10**	**8.0**	**78.8**	
Checks…………	1006	00	415	565	26	0.0	41.2	⅓ of all.
	839	38	485	265	51	4.5	62.3	All the fruit.
	774	98	531	120	25	12.7	81.3	" " "
Average…… …	**873**	**45**	**477**	**317**	**34**	**5.1**	**59.8**	

A single tree in the first group being exceptionally free from scab, the average percentage of fruits absolutely free is brought higher than in the other cases; but the average proportion of fruit which would be classed as "No. 1" is greater on those trees which were sprayed three times. With a single exception the amount of "No. 1" fruit on all sprayed trees is considerably greater than that on unsprayed trees, the average increase being 16.6 per cent. on trees sprayed twice, and 19 per cent. on those sprayed three times.

SUMMARY.

1. Spraying with copper solutions proves an effective means of checking the apple scab.

2. The average increase in the amount of salable fruit on the trees sprayed with the least effective solution over that on the unsprayed trees was 30 per cent. while the increase on trees sprayed with *eau celeste* was nearly 52 per cent.

3. *Eau celeste* proves more effectual than does the ammonio-copper carbonate solution but as used there was a slight injury to surface of the fruit.

4. Indications point strongly to the value of spraying early in the season, before the blossoms open.

5. Repeated applications of the fungicide during the season are beneficial.

Report of Botanist and Entomologist.

PROF. F. L. HARVEY.

PROF. W. H. JORDAN.

Dear Sir:—I have the honor to submit herewith my fifth annual report as Botanist and Entomologist for the Experiment Station. Judging from the number of letters received the past season, asking questions about plants, insects, fungicides and insecticides, there is an increased demand on the part of farmers in the State, for information upon Economic Botany and Entomology. Below will be found tabulated the more important plants and insects that have received attention during the past season. Those requiring more than a passing notice are considered in detail, and so far as necessary illustrated.

The past season has been somewhat remarkable because of the appearance in the State in injurious numbers of several insects that have not before been reported, viz: The Corn or Boll worm, which was found in the vicinity of Farmington feeding on sweet corn; the Chinch Bug, doing great damage to grass grounds in the vicinity of N. Fryeburg; the Horn Fly which proved quite annoying to cattle in the western part of the State, and *Bruchus obtectus*, *Say*, the Bean Weevil, boring in stored beans after the manner of pea weevils in peas.

We stated in our report for 1891, that the Fall Canker Worm had been increasing in the Penobscot valley for the past four years, and that considerable trouble might be expected from it in the future. It has proved very troublesome the past season about Winterport, Bowdoinham and Stockton, doing great damage to fruit and shade trees. We learned through a Vermont correspondent that the Apple Maggot, *Trypeta pomonella*, Walsh, infests pears in that State. As we have never seen it working in pears in Maine any information on the subject from Maine orchardists will be appreciated. We received specimens of the Melancholy Cetonia (*Euphoria melancholica*,) from Mr. John A. Smedberg, Unity, which were eating sweet corn at the top of the ear. So far as we know this habit has not been recorded. The Oyster-Shell Bark-louse must be doing great damage in Aroostook County judging from the badly infested specimens of apple twigs received from David Crane of Houlton. Those interested in this insect will find it considered in Expt. Sta. Rept. 1888, p. 157.

The Three-toothed Aphonus, accused of cutting corn in our last report, has been fully convicted of the charge the past season, by Mr. C. V. Manley of Auburn. He says, "I found this beetle which I send you, in a hill of corn with his head in a cut in the side of a stalk that had begun to wilt."

Mr. E. W. Merritt of Houlton, reports that he keeps the plant lice on his gooseberry bushes in check by removing the twigs bearing curled leaves in the fall. We have received insects during the past season from Illinois and California sent for determination by the editor of the Maine Farmer. Investigation of a species of mite called by us the Two-spotted Mite has been continued. This mite has done considerable damage the past season in the greenhouse at the college, and we found it had almost entirely destroyed a patch of German Wax Beans in our garden. Should it prove able to injure to any extent out of door plants, its capabilities of doing damage would be greatly enhanced. As we were doing laboratory work on the mite, it might have been carried to the beans on our clothing. We wish to study the coming season, insects affecting currant and gooseberry bushes, and will be pleased to receive specimens from all parts of the State.

We received from Mr. Ira Porter, Houlton, Maine a bunch of clover, *Trifolium medium*, L., in which the heads had assumed the form of conpound umbels. This was interesting as a confirmation of the belief by botanist, that the head, a kind of inflorescence found in the clover, is an umbel with the axis of inflorescence and the pedicils, shortened. Mr. Henry Sprague of Charlotte, for whom we examined some mosses last season in reference to their value as food for swine, reports that he fed during the winter about six barrels of *reindeer moss*, four of *hypnum splendens*, two of *sphagnum cymbifolium*, to three *swine*.

As the pigs all had other food he had no definite way of telling how much nutriment they got from the mosses. Thinks they liked either of the others as well as the reindeer moss. Thinks all had a constipating effect, which he overcame by liberal doses of sulphate of magnesia (salts).

Mr. W. H. Burgess of Monroe, says, that he grafts the Arctic and Lombard plums into the common Pomgranite and avoids the black knot, which has proved so destructive to plum trees in general. We don't know how thoroughly the experiments were tried, but have serious doubts about its being a protection. We doubt whether any of the varieties are exempt from this disease, though we admit that such a variety would be a great blessing to plum growers. We received from Mrs. Myra Damon, Newport, Maine, a specimen of Stinkhorn found in a cistern. These plants grow in decaying organic matter and are often found about sink spouts, drains and other places where decomposing organic matter occurs. They may be known by their curious habit of growth. At first they look like a puff-ball, finally the top bursts and from it comes a large spongy stipe which bears at the apex a slimy mass of brownish offensive spore bearing matter. The bottom part (utricle) of the form sent is about as large as a filbert, the stipe pink and three or four inches long. Finding it about the cistern would lead one to suspect that a sink spout or drain was too near, and that the water might be contaminated by it. These fungi are poisonous, but a single one in a cistern would not render the water harmful. Too great care cannot be exercised in placing drains and sink spouts where they cannot possibly contaminate water supply, as decomposing organic matter in drinking water is a very common source of diseases.

Samples of sage sent by Mr. Willard Lothrop, of Leeds Centre for examination as to adulterations, proved to be free from foreign matter, but were composed largely of old stems and poorly cured and blackened leaves. As to color and richness of flavor, the material was quite inferior, and would give dark color and poor flavor to sage cheese.

Walter M. Haines M. D., of Ellsworth, sent us some specimens of Fresh water cord Grass, and asked whether they were not Wild Rice. Wild Rice was sown quite largely in the marshes and ponds of Maine some years ago to attract water fowl, but so far as we know it has not become established in the State. If any one knows of its occurrence in the State, we would be glad to learn the localities. Mr. Fernald gives it in his Portland Catalogue as indigenous to the State, but we do not know the locality.

The Orange Hawkweed is spreading rapidly in the State and threatens to be a serious pest in meadows and pastures. Farmers should study the description given in this report, and be prepared to recognize the pest as soon as it appears, and destroy the straggling plants before they form large patches hard to manage. Below we give an extended account of the most important plants that have claimed attention during the past season.

The Potato Rot has been quite bad in the State the past season. We hope that potato growers will see the importance of using Bordeaux mixture to hold this disease in check. It has proved a great help in other States when applied at the time, or just before the disease makes its appearance.

REMARKS.

The cuts and plates to illustrate this report were obtained from the following sources: from the Department of Agriculture, Washington, D. C.; Cuts of the Orange Hawkweed, and of the Horn Fly. From Prof. S. A. Forbes, cuts of the Corn Worm and Chinch Bug. From Prof. F. D. Chester, cuts showing the results of spraying against Pear Leaf Blight. Plate II. is original.

Directions for sending specimens will be found in the Annual Report of the Experiment Station, 1888, p. 194, or in Maine Agricultural Report, 1888, p. 158. Correspondence regarding injurious insects and fungi is invited. Insects and plants will be named, and when injurious, remedies suggested. It is to the interest of farmers to detect injurious insects and fungi before they become established, so that remedial measures can be adopted before the pests are beyond control. As the Entomologist's duties prevent him from going much about the State, it is largely through correspondence that the Station learns of insects doing injury in the State.

INSECTS REPORTED AND EXAMINED—1892.

No.	Common Name.	Technical Name.	From Whom Received.	Remarks.
1	Cecropia Emperor Moth.	Platysamia Cecropia, Linn.	Ross C. Higgins, Thorndike. M. H. White, Bowdoinham.	Cocoons attached to branches of apple trees. See Ex. St. Rept. 1890, p. 121.
2	Fall Canker Worm.	Anisopteryx pometaria, Harris	M. H. White, Bowdoinham. Hon. F. Atwood, Winterport. Freeman Partridge, Stockton.	Eggs attached to apple trees, larvæ upon foliage, male and female moths about orchard. See Ex. St. Rep. 1888, p. 166.
3	Fall Web-worm.	Hyphantria cunea, Drury, = H. textor, Harris.	Ross C. Higgins, Thorndike.	Foliage of apple trees making a web at the ends of the branches. See Ex. St. Rept. 1890, p. 124
4	Corn or Boll-worm.	Heliothis armigera, Hub.	J. M. S. Hunter, Farmington. D. H. Knowlton, Farmington.	Boring through the husks and eating the kernels from the cobs of sweet corn.
5	Melancholy Cetonia.	Euphoria melancholica, Gory.	John A. Smedburg, Unity.	Eating sweet corn at the top of the ear.
6	Three-toothed Aphonus.	Aphonus tridentatus, Say.	C. V. Manley, Auburn.	Cutting off stalks of sweet corn in the hill. See Ex. St. Rept. 1891, p. 199.
7	Plum Curculio.	Conotrachelus nenuphar, Herbst.	H. T. Cummings, S. Paris.	Pears badly punctured by this insect. See Ex. St. Rept. 1888, p. 178.
8		Pasimachus species.	Ross C. Higgins, Thorndike.	On the ground; a beneficial species feeding on other insects.
9	Scabrous Osmoderma.	Osmoderma scabra.	Ross C. Higgins, Thorndike.	Found on an apple tree. Larvæ bore in apple trees.
10	The Squash Bug.	Anasa tristis, De Geer.	S. Dill, Soquel, Cal.	Feeding on squashes.
11	The Chinch Bug.	Blissus leucopterus, Say.	W. B. Nutter, B. Walker McKeen, Simeon Charles, N. Fryeburg.	Destroying Timothy meadows.
12	Currant Worm.	Nematus ventricosus, Klug.	H. H. Osgood, Blue Hill.	Eating foliage of currant bushes. See Ex. St. Rept. 1888 p. 182.
13	Oyster-shell Bark-louse.	Mytilaspis pomorum, Bouchè.	David Crane, Houlton.	Badly infesting the branches of apple trees. See Ex. St. Rept. 1888. p. 157.
14	The Horn Fly.	Haematobia serrata.	Hon. B. W. McKeen, Augusta.	Troublesome to cattle.
15	Two-spotted Mite.	Tetranychus 2-maculatus, n. sp.	Prof. L. H. Bailey, Ithaca, N. Y., and others.	A bad pest in hot houses and also affecting house plants and sparingly out of door plants.
16	Wood Louse, or Sow Bug.	Porcellio species.	Henry Roffe, Orono.	Mistaken for the Buffalo Carpet Beetle. Lives on decaying wood and organic matter.
17	Long Horned Wood-borer.	Monohammus titillator. Fabr.	O. F. Brigham, Newport.	A wood borer.

PLANTS RECEIVED FOR EXAMINATION—1892.

No.	Common Name.	Scientific Name.	From Whom Received.	Remarks.
			WEEDS.	
1	Fall Dandelion.	Leontodon autumnale, L.	Henry Norcross, Augusta.	Weed in meadows.
2	Orange Hawkweed.	Hieracium aurantiacum, L.	Geo. W. Chamberlain, Calais. H. L. Leland. E. Sangerville. G. S. Paine, Winslow.	Weed—meadows, roadsides and pastures.
3	Canadian Hawkweed.	Hieracium Canadense, Michx.	I. T. Merrill, China.	Border of fields; not a bad weed.
4	Knapweed.	Centaurea nigra, L.	I. T. Merrill, China.	Weed in fields; should be looked after.
5	Rabbit-foot Clover.	Trifolium arvense, L.	I. T. Merrill, China.	Weed—roadsides, etc.; very common in Maine.
			GRASSES.	
6	Red Top.	Agrostis alba, L. Var. vulgaris, Thurb.	S. H. Berry, Wayne.	Sold by Parker & Wood. Boston, as Kentucky Bluegrass, (*Poa pratensis*, L.)
7	Freshwater Cord-grass.	Spartina cynosuroides, Willd.	Walter M. Haines.	Sent to learn whether it was wild rice.
8	Orchard Grass.	Dactylus glomerata.	Joseph F. Warren, W. Buxton.	Growing in grass ground.
			FUNGI.	
9	Pear Leaf Blight.	Entomosporium maculatum, Lev.	Arthur D. Moore, Portland.	Parasitic on leaves of pear trees causing them to curl, turn red and drop; a bad disease.
10	Hair Mold.	Phycomyces nitens.	N. H. Martin, Fort Fairfield.	Growing on excrement of cats in a potato hill. Not of special economic importance.
11	Anthracnose.	Glæosporum venetum, Speg.	Chas. S. Pope, Manchester.	Raspberry bushes badly infested.
12	Anthracnose.	Glæosporum venetum, Speg.	H. H. Osgood, Blue Hill.	Affecting Shaffers Collosal Raspberry.
13	Stinkhorn.	Mutinus Ravenelii, (B. and C.) Fisch.	Mrs. Myra Damon, Newport.	Found in a cistern. An offensive, poisonous species.
			MISCELLANEOUS.	
14	Zigzag Clover.	Trifolium medium, L.	Ira J. Porter, Houlton.	Heads changed to compound umbels Flowers malformed and dwarfed.
15	Golden Rod.	Solidago squarrosa. Muhl.	E. F. Hitchings. Bucksport.	Sent for verification.
16	Golden Rod.	Solidago latifolia, L.	E. F. Hitchings, Bucksport.	Sent for verification.
17	Aster.	Aster acuminatus, Mx.	E. F. Hitchings. Bucksport.	Sent for verification.

BOTANY.

FALL DANDELION.

Leontodon Autumnale, L.

(Ord. Compositæ.)

The above species continues to be reported as troublesome in grass lands. It has a firm hold in the State, and should be known by farmers so they can check it before a whole field is overrun. When there are only a few plants, the extermination is a simple matter, but if neglected serious trouble will follow. Much of the clover seed offered for sale in this State contains the seed of this weed.

The following reply to Mr. Henry Norcross may interest others.

Mr. Henry Norcross of this city, brought a specimen plant to this office for identification. He says his fields are infested with it, and that it is killing out the grass far and near. We forwarded the sample to Prof. Harvey, Botanist at the Experiment Station, who kindly forwarded the following to the *Farmer:*

The plant you enclose for determination belongs to the sunflower family (*Compositæ*) and is called by botanists, *Leontodon autumnale*, *Linn.* Its common name is Fall Dandelion. The Latin name means the *Liontooth that blooms in the autumn.* The leaves are incised, suggesting the name of liontooth. The plant is a native of Europe, but is thoroughly naturalized in the United States, and quite widely spread. It is especially plentiful in New England, and a bad weed. Being an abundant seeder and a perennial, it is hard to exterminate. It grows under the most unfavorable circumstances, and will replace grasses in meadows. Should it become too abundant, there is no way to destroy it excepting cultivation in some hoed crop until it disappears. The plants about roadsides, edges of fields and lawns, should be pulled by the roots, or kept from seeding by careful mowing. In this region it is abundant along the roadsides, and is increasing. Occasionally a field is noticed nearly overrun with it. Roadsides are prolific seed gardens that supply the public gratis with an abundance of seeds of the vilest weeds. The town authorities should be empowered by law to exterminate patches of weeds that appear, and might become the centres of distribution of troublesome pests. This weed will be found figured and described in Experiment Station Report, 1890, p. 120.

F. L. HARVEY,
Botanist for the Station.

ORONO.

ORANGE HAWKWEED.

Hieracium aurantiacum, Linn.

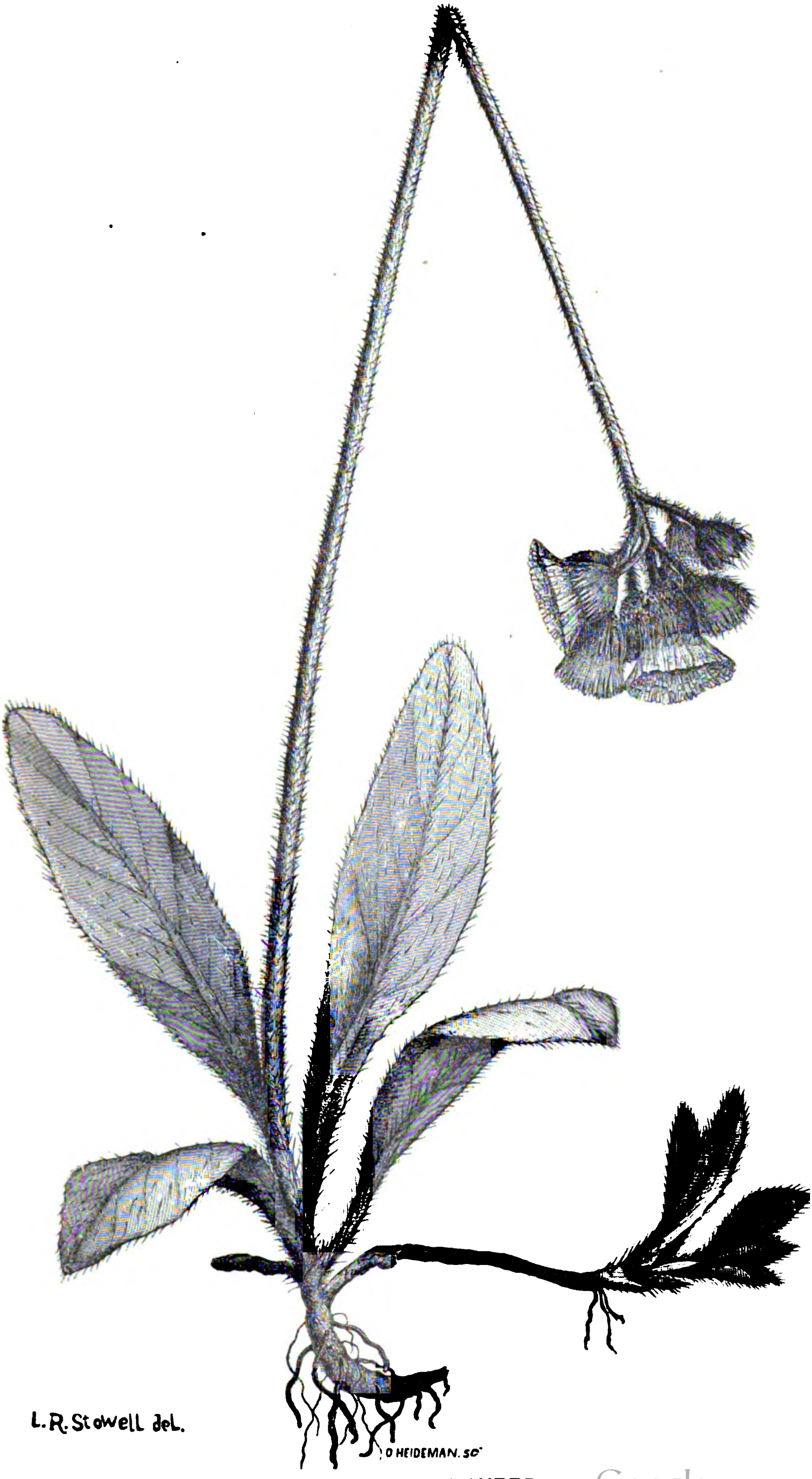
(Ord. Compositæ.)

The following letters were received the past season at the Station regarding the above plant. They show how rapidly the weed is spreading, and what a bad pest it is regarded by farmers. The plant has been found in limited quantities on the College farm in a pasture near the river, and has not spread very much in that place but the past season we noticed it in several places in the meadow land. Mr. James Walker of Bangor, reported a field of several acres near Pea Cove, nearly overrun with it. Mr. George W. Chamberlain reports it from Calais. These together with the localities given in the following letters show it is widely distributed in the State. The question so pointedly asked by Mr. Paine, whether "*we are at the mercy of our neighbors in the matter of spreading weeds*" is one that should seriously claim the attention of the legislature. There should be a law preventing farmers from harboring vile weeds in their fields or letting them grow at the roadsides on their premises. On property for which no one is especially responsible, the dangerous weeds should be eradicated at public expense. Why do not farmers urge some enactment for their protection? There should be a law subjecting seed sold in the State to inspection. The character of the seed sown is as important as the composition of the fertilizer used.

WINSLOW, ME., June 20, '92.

THE STATE AGRICULTURAL COLLEGE,
For the Prof. of Botany,
ORONO, ME.

DEAR SIR:—About two years ago I sent you, I think, a plant found in this vicinity which you identified as the Orange Hawkweed. It was not regarded as a dangerous weed at all. I wish to give my experience with it and ask if there is any way to compel farmers to stamp out such weeds under our law. I have fought it on this farm for about five years. It comes from a farm one-fourth miles square, two narrow farms intervening, and these farms are getting rapidly stocked with it. I have watched it with the greatest care and have picked it clean the middle to the last of June, and again scoured the fields after the haying and at frequent intervals till fall. In spite of the greatest care it is



ORANGE HAWKWEED

(*Hieracium aurantiacum*, Linn.)

gaining on me, and when these other farms are well covered I shall have to give it up. I am surrounded by the wild carrot, and have no difficulty in keeping it off the farm, but the Hawkweed, one of the vilest to the smell, seems almost impossible to eradicate. In my opinion, if its behavior indicates anything, it is the most dangerous weed that has threatened us, not excepting the Canada thistle. Will you be kind enough to inform me if we are at the mercy of our neighbors in the matter of spreading such weeds? A line from you will greatly oblige

Yours very respectfully,
G. S. PAINE.

EAST SANGERVILLE, ME., July 1, 1892.

BROTHER BALENTINE:

Find enclosed a plant (weed) that is rapidly encroaching into fields and pastures. It is known locally as *Missionary* weed. Its mission however is one not to be desired. The weed is described in the Report of the United States Department of Agriculture 1890 under the name Orange Hawkweed. This plant is rapidly spreading in the county from many different points. A recent trip in the town of Guilford and Foxcroft showed many fields completely overrun. The village streets and numerous grass flats in Foxcroft village are painted red with this weed. In fact it is a *monopoly* plant taking full possession of the soil, and destroying everything else. Do you know whether the weed is common in the State? It seems to me it cannot be, as I do not remember to have seen anything said of it in the Agricultural papers. Can you or any of your associates tell us how successfully to fight it? If you know aught of it, and methods of eradication please give them to me for publication in the Piscataquis Observer.

The rapidity with which this weed is taking possession of our fields is alarming to our farmers.

Truly, H. L. LELAND.

REMARKS.

This weed has recently been introduced into the Eastern United States from Europe. It has been in Maine on the College farm for at least ten years, and according to Mr. Paine, about Winslow for more than five years. We have no knowledge of the time or place of its introduction in the State. Such things are scarcely ever noticed until they do injury, when it is often too late or very troublesome to eradicate them. The experience of Maine farmers shows that the plant does not confine itself to roadsides and pastures, where the grass is short, but encroaches into meadows and overruns them. The plant being a perennial and developing runners and root-stocks, makes it a very difficult weed to control. Nothing short of destroying the roots will suffice. Besides, it is so hardy and tenacious of life that it takes almost complete possession of the soil. It is prolific of seeds, which are provided with a row of bristles (pappus), giving it the power of wide dissemination by the wind. We will be pleased to hear from anyone who has noticed this weed and to learn how long it has been known or anything regarding its introduction in the State. On the opposite page we give a cut of this weed and below a description, both copied without change from the United States Department of Agriculture, Report for 1890. They will enable anyone to recognize this vile weed.

"Perennial by slender root stocks and by runners; Stem simple, erect, one to one and one-half feet high, nearly leafless, densely hirsute, the hairs toward the apex of the stem black at the base; leaves mostly radical, oblong-lanceolate, denticulate, hirsute on both sides, sessile, those of the stems two or three; all but the lowest reduced to bracts; heads in a bracted cyme; peduncles with black, glandular hairs and a close brown coating of stellate hairs; involucre about one-third of an inch in diameter, its bracts linear-lanceolate, little imbricated, provided on the back with straight, glandular and stellate hairs; flowers all perfect, with ligulate orange-covered corollas; achenia about one line long, darkbrown, linear in outline, terete, ten-ribbed, truncate; pappus a row of dirty white bristles."

Leaf Blight of the Pear.

Entomosporium maculatum, Lev.

Attention has been called to the above fungus as doing damage to the leaves and fruit of pear trees in Maine.

The letters from Mr. Moore given below will indicate the nature of the inquiries. Mr. Moore's pear trees are located upon Diamond Island, Portland Harbor.

May 24, 1892.

Horticulturist Maine Experiment Station.

Dear Sir:—I enclose a few leaves from my Clapp's Favorite pear tree.

The leaves began to have this appearance two seasons ago, on one branch of the tree. Last year more branches were effected, and this year it seems to have spread over the whole tree. Is it Pear blight? and is there any remedy?

Yours Respectfully,

Arthur D. Moore.

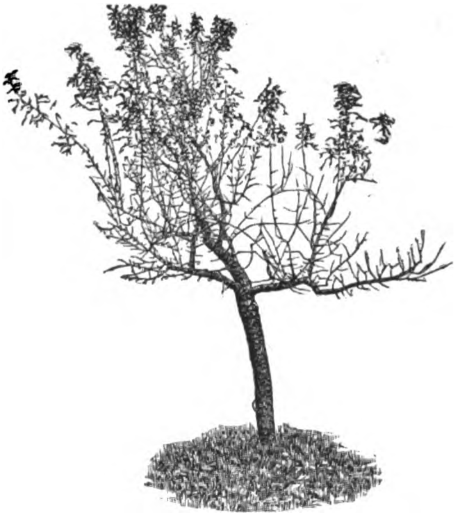


Fig. 1. *Tree not sprayed.*

The above letter shows how rapidly this disease spreads, and the necessity of applying remedial measures as soon as possible. We recommended the use of the ammoniated carbonate of copper solution, made as follows:

Dissolve three ounces of carbonate of copper in two quarts of commercial ammonia water (22°) and dilute with water to thirty-five gallons.

The first application should be made when the leaves are half grown and repeated according to the severity of the case every three or four weeks during the season.

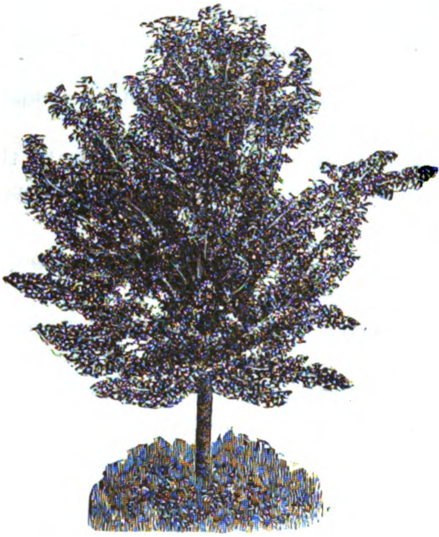


Fig. 2. *Showing beneficial effects of spraying.*

The experiments made by Mr. Chester of the Delaware Experiment Station, in 1891, show that the carbonate of copper and carbonate of ammonia solution is cheaper, as well as one of the most effective of the copper compounds used as fungicides. It is made as follows: Mix three ounces of carbonate of copper with one pound of pulverized carbonate of ammonia; dissolve in two quarts of hot water and dilute further with water to fifty gallons. Figures 1 and 2 show the relative condition of sprayed and unsprayed trees.

Mr. Moore made the following report:

Jan. 3, 1893.

PROF. F. L. HARVEY,

DEAR SIR:—Yours of the 27th at hand. I sprayed my pear trees with the ammonia and copper carbonate solution, according to directions as nearly as possible, June 13 and again July 16.

The fungus had already appeared when the first application was made, but it did not spread nor seem to kill the leaves as much as the year before. The leaves remained upon the trees this year until the usual time, whereas in '91 that part of the tree affected was entirely bare for a month before it should have been. I think the spraying has been of great benefit and will eventually cure the disease.

I thank you very much for your kindness to me, and for the interest you have taken in the matter. I also wish to thank you for the reports which you so kindly sent me. I have enjoyed them very much and have found much in them of value to me.

I will write you again in regard to the pear trees when the leaves appear next spring.

Yours respectfully,

ARTHUR D. MOORE.

P. S. The spraying seemed to stop the disease just where it was. In '91 it spread all over the leaf and seemed to burn it all up, so that they were all dead by the last of August.—A. D. M.

CHARACTERS OF THE FUNGUS.

This fungus causes a premature discoloration and dropping of the foliage and in some cases the spotting and cracking of the fruit. It has done considerable damage to pear and quince orchards. It does not seem to be as bad in Maine as in the Atlantic States farther South, but it is here and should be known and precautions taken to prevent its spread. Sometimes the leaves all drop early, but usually they drop slowly during the season. The leaves are unhealthy, the trees do not make a normal growth and sometimes a second blossoming occurs.

The disease first shows itself in the form of minute red spots, which increase in number and size and finally cause the leaf to shrivel and drop. The tender twigs are affected and often destroyed. The disease upon the fruit causes it to crack, through which germs enter and cause early decay.

BLACK OR HAIR MOLD.

Phycomyces nitens.

We received the above-named fungus from Mr. Martin, and as the species is quite common in Maine we give Mr. Martin's letter and an account of the plant.

FORT FAIRFIELD, ME., March 31, 1892.

FRIEND JORDAN,

DEAR SIR:—Enclosed with this letter you will find a piece of an elephant potato, to which is attached a hairy mane.

In the same hill there grew seven potatoes, all of which had a hirsute growth similar to the enclosed.

Will you please let me know whether this is the much-sought-for missing link, or what it may be?

This has elicited much curiosity and we would like to know of what nature it is.

Respectfully yours,

N. H. MARTIN.

The above-named mold belongs to an order of fungi known as *Mucorini* or *Black Molds*. The species of the genus *Mucor* are quite common on decaying organic matter and are frequently seen on rotten potatoes, squashes, pumpkins and other vegetables in the garden and in the cellar. They also are very annoying to housewives, appearing quickly upon bread, or cooked vegetables kept in warm, moist places. They may readily be known by their smoky black color, and the dense, erect coating of fine thread-like fibres with which they cover the substance attacked. These fibres bear at the ends small, round head like fruits, that are filled with small, oblong bodies called *spores*, capable of reproducing the mold. Where the fibres cross, spore-bearing bodies are also produced by a sexual process called conjugation. These spores have great vitality and will grow after they have been dried a long time. This accounts for their being everywhere. The spores are light and can be carried a long way by wind. A dry atmosphere is always prejudicial to their growth. The specimen sent by Mr. Martin is not a *Mucor*, but belongs to the genus *phycomyces* of the same *family*. It is quite common in Maine, but prefers oily instead of starchy substances to feed upon. We have frequently found it upon the excrement of cats, which was buried in dirt, or spent ashes out-of-doors, or more commonly in cellars that cats have access to, or under out-houses. The fibres of this plant are sometimes six or eight inches long and in dark cellars a beautiful, glossy black and wonderfully like hair in appearance. The specimens grown in more light, or in the laboratory, are less luxuriant and paler colored. The common species of *Mucor* are much smaller and shorter fibred. The spores of specimens kept in a dry laboratory for five years, germinated readily on bread in a moist chamber. This species of *phycomyces* showed streaming of cells contents (cyclosis) very nicely in a double current along the walls of the cells which joined at the end and flowed back down the centre.

The origin of the specimens sent by Mr. Martin was plainly the excrement of some animal that had been buried in the potato hill. The specimen submitted was growing on excrement, not on a piece of potato. If the potatoes of the hill were affected the fungus originated in the excrement and spread to them. This fungus is interesting, and is sure to attract attention, though it is not to be regarded as especially injurious.

ANTHRACNOSE OF THE RASPBERRY AND BLACKBERRY.

Glœosporium venetum, *Speg.*

Mr. Chas. S. Pope, of Manchester, Me., sent us the past season a bundle of raspberry canes badly infested with the above disease. He said: "My bushes are all dying with this disease.

They were obtained from a neighbor, who had them from Anderson, of N. Y. I find that my neighbor's are also dying with the same disease." Mr. H. H. Osgood, of Bluehill, reports the same disease as affecting his bushes of *Shaffer's Colossol* raspberry.

History. This disease was first considered by Prof. Burrell under the name "Raspberry Cane Rust," but it is now generally known as *Anthracnose.* It is a foreign species, but has become widely distributed in this country and does much damage to raspberries and blackberries.

Characters. It attacks the canes, leaves, petioles of the leaves, and in some cases the fruit. It attacks both the fruiting and non-fruiting canes. It first appears near the base of the canes as small, purplish spots. As the disease advances it encroaches upon the tops, and in the last stages will attack the petioles, leaves and fruit. The purplish spots enlarge and finally coalesce, producing irregular, light-colored, blister like patches, often over an inch long and sometimes encircling the stem, producing the same effects as girdling with a knife. The leaves and fruit are much dwarfed from a want of nourishment and finally the plants die. The disease lives over winter upon the young canes attacked. and renews its ravages the next season.

The fungus producing these effects is a microscopic, internal, thread-like parasite, that creeps between the cells of the host plants, sapping their vitality. It does not usually enter the pith, but confines its ravages to the cells of the bark and cambium layer, causing them to shrivel and die. Near the centre of the diseased spots, where the ends of many of the capillary threads of the fungus meet and unite, are formed masses of short, club-shaped bodies called *basidia.* These are formed under the epidermis of the bark and finally burst it, appearing enveloped in a globule of gelatinous matter. Upon the ends of these basidia are borne singly, small, colorless, oblong, or oval celled bodies called *spores.* The spores are the reproductive elements and serve to spread the disease to adjoining plants and patches. The spores are held together in the gelatinous matter, which is soluble in water. The spores are liberated during rains and rapidly germinate in drops of water on the plants. Dry weather prevents the spread of the disease to new places, though the fungus will continue to grow in dry weather on canes where it is established. Spores liberated by rains are in a condition to be blown by the wind after the rainwater evaporates. Spores taken from specimens kept in the herbarium for several months will germinate, showing the vitality of this parasite, and warranting the belief that the fungus will live over winter in the canes.

PRECAUTIONS.

(*a.*) In the case of Mr. Pope's plants the disease was no doubt on the canes when planted and probably on his neighbors' bushes when they came from the nursery. We reiterate the importance of carefully examining nursery stock before planting it, to see whether it is affected by fungus or insect parasites. If found to be affected by a fungus it should be burned without delay.

(*b.*) As it seems quite certain that the spores of this disease survive the winter in old canes, those that are through bearing, or dead, or badly affected, should be removed at the close of each season and burned.

(*c.*) As moisture favors the growth of fungi the plants should be trained and framed so as to admit as free a circulation of air and light as possible. Planting in rows six feet apart and the plants five feet in the rows will admit plenty of light and air, and will admit of cultivation each way.

(*d.*) Spraying with a solution of sulphate of iron (green vitril) two pounds, to five gallons of water, before the buds start in the spring has been recommended.

(*e.*) Should the disease appear after the leaves are expanded the use of Bordeaux mixture is recommended.

REMARKS.

Those who wish to read a fuller account of this disease will find it considered in the Report of the U. S. Department of Agriculture, 1887, page 357, and illustrated on plate V.

THE POTATO BLIGHT.

Phytophthora infestans, De Bary.

To determine whether the germs of potato rot live over winter in the soil, or are planted in the seed, the following experiment was performed:

A quantity of rotten potatoes from a badly infested patch was gathered and buried in the ground under as natural conditions as possible. The next spring, two lots of seed that had shown no evidence of rotting in the cellar, were selected and planted as follows:

1. Two rows, one of each kind of seed, on the ground where potatoes rotted badly the past season.

2. Two rows one of each kind of seed upon land that had not grown potatoes for two seasons.

3. Two rows planted as in lot 2, but each hill infested with the rotten potatoes buried the fall before.

All the rows were fertilized alike with phosphates and ashes.

Results.

The disease did not appear in any of the rows.

This would indicate, so far as one experiment goes, that the germs do not survive the winter in the soil, and would emphasize the importance of selecting seed free from the rot. We are not satisfied with the results and will repeat the experiment.

Bordeaux Mixture for the Rot.

Mr. B. Walker McKeen has experimented with Bordeaux Mixture the past season, to prevent potato rot and we give below his interesting and suggestive report.

AUGUSTA, Dec. 31st, 1892.

DEAR PROF. HARVEY:

In reply to your favor of yesterday, asking for my experience with the Bordeaux Mixture for potato blight, I will say, that I used the mixture quite thoroughly through the entire season, putting it on three times, but the results were not such as to warrant me in recommending it to farmers without another trial. I raised a very fine crop of potatoes, all of good size, and the rust did not affect them to any great extent. Still there were some other pieces quite near me that were not affected materially. Other pieces suffered quite badly. I am inclined to the belief, that a *liberal fertilization* of the ground for potatoes will tend to place them beyond the reach of the rust, and that in this way farmers may prevent its ravages, in a great measure. Still I am prepared to say that I shall *certainly* use the mixture another year, as I am not yet prepared to condemn it, as I certainly think my crop was increased by its use. I hope to be able to report more fully after another trial.

In addition to my own experience, I might say that I furnished a neighbor material enough to put upon a small part of his piece and that he used it but once, and he is willing to say that the tops where the mixture was used remained green much longer than those which had not been treated, the difference being so great that the neighbors in passing stopped to learn the cause; but the difference in the crop was not what he expected it would be, from the looks of the tops. He will use it largely next season.

Yours very truly,

B. WALKER McKEEN.

In reference to the plan of liberal fertilization suggested by Mr. McKeen, it is well to remember that a patch of potatoes may be destroyed by potato blight in *two* ways. The germs of the disease may be in the seed, or in the soil upon which the potatoes are planted. In either case the germs would soon enter the young plants, grow with them and finally destroy them. In the second case the soil and seed may be *entirely free* from germs and the crop almost reach maturity and then becomes infested by *summer spores* blown from an adjoining patch and rapidly destroyed.

It is a principle, equally applicable to plant and animal life, that healthy specimens (all other conditions being equal) are stronger and better able to resist the attack of diseases and parasites. It is also a good rule to fertilize highly and feed animals well for by so doing the profits are greater.

It must be also remembered that plants under cultivation and animals under domestication make a more rapid growth than in nature, and that their tissues are much softer, and when once attacked by a fungus or parasite they become an easier prey.

If the higher fertilization of potato land will hasten the maturity of the crop, and thus prevent infection from the poorly fertilized lands of a shiftless neighbor, it would be an advantage.

If the germs are already in the patch, high fertilization would make the plants more succulent and give the disease a better hold.

An overgrown patch would also fall an easier prey to summer spores should they reach it at the right time

We believe it is better to adhere to the rule, that *adequate fertilization is always best* and prepare ourselves to fight the parasites that are sure to attack the soft tissues of cultivated plants. The planting of early varieties would be an advantage, providing our neighbors grow the later sorts.

Bordeaux Mixture cannot destroy the potato rot in plants where it is established. It can only prevent the disease *spreading* by destroying the summer spores.

In experimenting with Bordeaux Mixture some rows in the patch should be left unsprayed to serve as a check.

Bordeaux Mixture is a fungicide of great promise and we hope others will try it and report the results.

ENTOMOLOGY.

FALL CANKER-WORM.

Anisopteryx pometaria, Harris.

(Ord. Lepidoptera: Fam. Phalenidæ).

This insect is increasing rapidly in the State. We have spoken in previous reports about its increase in Penobscot County, but it is also increasing in other counties. Mr. Freeman Partridge writes that it has done great damage about Prospect in Waldo County. Mr. C. A. Arnold, Arnold, Me., says: "They are the curse of my young apple trees, doing more damage to them by destroying the leaves and blossoms than all other insects combined." The shade and orchard trees about Orono were badly infested the past season. The garden fences in some parts of Orono were literally covered with egg clusters. As the insects feed largely on the tall elms and other shade trees and forest trees, there is no hope of exterminating them by confining our remedial measures to the orchard. We must take steps to keep them out of shade trees or they will continue to breed there and transfer their depredations to the orchard.

Mr. Partridge says the Canker-worms have troubled him for three years, increasing each season. Though the spraying done did not kill the Canker-worms it did destroy the *Codlin Moths*. He says he did not find a bushel of apples affected by this insect in his whole orchard, while he has had them in abundance before. This would indicate that the time to spray for Codlin Moths was about the time the Canker-worms are grown. We suggested the use of a band around the tree to prevent the *wingless females* ascending to lay their eggs. Mr. Partridge writes: "There is a bug nearly as big as a house fly that is crawling on the trees. I send you two. The little wingless bugs are lively on the south side of the trees though the snow is three or four inches deep among the trees." The insects spoken of above were the wingless females of the Canker-worm.

REMEDIES.

We would advise a trial of a tin band, which consists essentially of a band or circle of tin a few inches outside of the trunk of the tree, held there by a circle of muslin attached to the tin at its edge and drawn with a cord at the top, so as to fit the tree closely and prevent the insects from getting up without going over the tin. The tin is kept covered with a mixture of equal parts of castor oil and kerosene. As soon as they touch this they fall to the ground. The muslin can be fastened to the tin by turning over the edge of the tin before it is bent to a circle and inserting the edge of the muslin and hammering them together. The tin should be about three inches wide and long enough to stand out three or four inches from the tree, when bent around it and fastened by rivets. The whole inner surface of the tin is daubed with the mixture of castor oil and kerosene. The mixture should be renewed occasionally and the bands kept on the trees until the moths disappear. Fig. 3 shows the nature of the band and the way to attach it. Should the trees be full of eggs or young caterpillars then spraying would have to be resorted to.

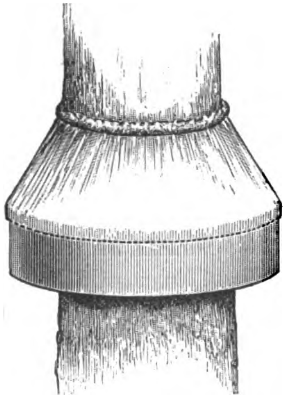


Fig. 3.

Mr. Partridge believes in thorough work and sprayed, using one-half pound Paris green to a barrel of water, consequently the leaves of Tallman Sweets were injured. He speaks of the flower buds of his trees being eaten, apparently before they open. This may have been done by the *Eye-Spotted Bud Moth;* see Sta. Rept. 1888, p. 169, also Rept. 1890, p. 128. The spraying should be done early enough to catch the young worms before they do much damage to the foliage. The time can be determined by watching a few clusters of eggs and when they are hatched the mixture should be applied, or to be safe two sprayings could be made, one just as the leaf buds are bursting and another a week later. While the leaves are young and tender we would advise a weak mixture, say one pound to two hundred gallons. It is a great shock to a tree to loose its foliage if it is not killed. The leaves are the food formers for the plant. They elaborate the food necessary to make the new wood and perfect the fruit, also it is their office to store, in the new wood and buds, the material necessary to form the leaves the next season. *It is important* to clear the trees of leaf-eating insects as early in the season as possible.

The reader will find an account of the habits of this insect in Expt. Sta. Repts. 1888, p. 166, and 1890, p. 137.

There is an insect closely related to the Fall Canker-worm known as the Spring Canker-worm. It differs principally in spending the winter in the ground, emerging very early in the spring and laying its eggs which soon hatch. The Fall Canker-worm changes to the moth state in the fall when the eggs are laid and do not hatch until spring. We have not noticed the Spring Canker-worm to any extent in Maine. We have at present to do with the more abundant one.

The females of both species are wingless, and as both feed on the foliage, spraying would be equally remedial for both. For the spring species bands would have to be applied in the spring. The bands on the trees in the spring would prevent the young caterpillars of both species climbing the trees.

THE BOLL-WORM OR CORN-WORM.

Heliothis armiger, Hübn.

(Ord. Lepidoptera: Family Noctuidæ).

Last September we received a package of sweet corn from Mr. John M. S. Hunter of Farmington, Me., and the following communication:

CHRONICLE OFFICE,
FARMINGTON, ME., Sept. 10, 1892.

SIR:—I send you by express to-day a box containing ears of sweet corn. A gentleman in this village planted the corn (sweet corn) in his garden. He tells me every hill is affected and corn in same condition as that which I send you. Will you please look it up and tell the readers of my paper what these worms are and how to exterminate them. This is a great sweet corn region and farmers fear these worms will give them trouble.

JOHN M. S. HUNTER, Editor.

About the same time we received specimens of the same insect from Mr. D. H. Knowlton, Farmington, Me., and learned from other sources that it was doing considerable damage to sweet corn in that vicinity.

The ears of corn received, each contained from one to half a dozen worms, snugly concealed beneath the husks at the top of the ears, that were feeding on the kernels. In some of the ears the kernels had been eaten nearly clean on the upper third of the cob. In some of the ears the worms had eaten most of the silk, and in others holes were gnawed through the husks at various places. We at once recognized the worms as the larvæ of the Cotton Boll-worm, an insect that has done untold damage to cotton, corn and various other crops in the West and South. This insect has done more damage in the Southern and Middle States than in the extreme Northern, but judging from the specimens received, it finds congenial conditions in the sweet corn fields of Maine. There is reason for serious concern regarding it, for if it maintains itself and increases, it will jeopardize the corn packing industry.

The damage done is not confined to the kernels eaten. The sap exudes from the kernels gnawed and ferments, so that it would be impossible to use the affected ears for canning. The exuded sap invites a host of smaller insects and fungi to share in the spoils. The husks being left open by the worms eating the silks, allows rains and dew to enter and favor the growth of moulds.

It would not pay to examine carefully each ear to see whether it harbored worms, small insects or fungi before cutting it for canning. Practically a crop much infested by this insect would be worthless for canning, and would have to be utilized so far as possible as food for stock.

If the insect confined its ravages to corn alone it might have a hard time to perpetuate itself on account of the sweet corn being gathered before the worms have their growth. Some of the worms in the corn sent were not more than one-third grown, others were half grown and only a few mature. We put them in a breeding cage and the smaller ones lived until December and died without entering the pupa state, while the larger ones remained gnawing the ears for several weeks before entering the ground.

We are inclined to think the larvæ may in some cases hybernate. The insect is quite a general feeder having been known to do much damage to peas, beans, pumpkins, tomatoes and tobacco, and probably has still other food resources. It should be careully watched for the next two seasons, and if it shows a tendency to increase and spread, concerted action should be taken to exterminate it. That the insect may be known when seen, we give below a condensed description of it in the various stages of its life history and also cuts of the eggs, larva, pupa and moths.

DESCRIPTION.

Eggs—nearly globular, a little flattened at the base, with a slight depression at the top and a series of depressions running from this depression to the base; diameter .025 inches; color pale straw. The moths are said to be capable of laying five hundred eggs which are placed singly upon the leaves by the first brood, and upon the silks and husks at the top of the ear by the later brood. The time required to hatch is supposed to be from two days to a week. Two views of the eggs magnified are shown in Fig. 4, a and b.

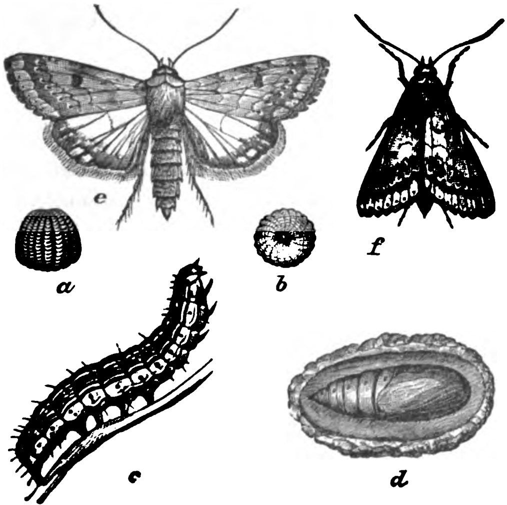


Fig. 4.

Larva—length 1.5 inches when full-grown; color variable, some being pale brown, striped with darker brown, others pale green striped with darker green. There is a dorsal brown band bordered by a narrow light line followed by a darker band that reaches to just above the breathing pores (stigmata) while the stigmata are in a light area that extends to the ventral surface which is of the general body color. On each segment are eight shiny black spots from which arise brown hairs. The four black spots on the back of each segment are arranged in the form of a trapezoid, with the parallel sides transverse with the body, the shortest side toward the head. The two black spots on the sides are just above the stigmata, one above and in front, the other back and on a line with them. Head and legs brown, shield on the neck (cervex) dark brown. A few short hairs scattered over other parts of the body. See Fig. 4, c. When full grown the worm enters the ground, forms a cocoon of earth interwoven with silk and changes to the chrysalis.

Chrysalis—length .8 of an inch. Color light chestnut brown, the dorsal line, stigmata and divisions of the segments darker. Rather slender, an indentation on the back where the abdominal segments begin, the last four segments moveable, two thorns at the extremity. See Fig. 4, d, which shows the chrysalis in the cocoon.

Moth—expanse of wings 1.5 inches. The color is quite variable in depth of shading. The more common color of the fore wings is pale clay yellow, with a faint greenish tint, and marked with darker olive, dark brown, or even black. A dark, conspicuous spot near the middle of each fore-wing. Hind wings paler with a dark brown band along the outer margin interrupted in the middle by a large pale spot.

The moth with expanded and closed wings is shown in Fig. 4, e and f.

LIFE HISTORY.

In Maine there is probably only one brood of the moths, at least we have no evidence bearing upon the subject to indicate more than one. The moths probably are on the wing early in August. (The larvæ we received on September 10th were of various sizes, some full grown, and though we have not taken the moths in Maine we know the larvæ require three or four weeks to mature, and the eggs several days to hatch which would require that the moth be on the wing early in August). The small worms found in the corn received were from eggs laid on the same ears later, requiring that the moths continue on the wing for some weeks or the time of emerging from the chrysalis extends over considerable time.

The moths mate and the females lay their eggs probably one in a place upon the food plant. They are on the wing early in the evening. The eggs are laid upon the leaves, tassels, silks or husks and hatch in a few days. The worms gnaw through the silk at the top of the ears and feed upon the kernels forming channels at the top of the ears. They will gnaw holes through the silk and go to other ears on the same stalk or even go to new hills. After feeding about three weeks or longer according to the season and the weather, they are mature and make their way to the ground choosing preferably a spot where the earth is compact, burrow beneath the surface making a round hole which widens toward the bottom and is slightly closed at the top. In this gallery they change to the pupa state. Where there is only one brood they hybernate in the pupa state and appear the following season and the round of life is complete.

REMEDIES.

Natural.—Bacterial diseases of the worm, moth and eggs are known, besides a half dozen or more insect parasites, Tachinas Ichneumons, prey upon them in the larval state. Lady birds, several species of hyemenopterous insects, tiger and ground beetles prey upon them, and chalcid egg parasites on the eggs. Bats and other insectiverous animals eat the moths. Insectiverous birds and barnyard fowls are fond of them and destroy both worms and moths. Ants and spiders destroy the eggs and young. It is also well known that they will eat each other.

Artificial.—In the extreme North where there is probably but one brood this insect would be more easily checked than where there are two or three broods in a season. Where there are several broods a few survivors of the winter would in the last brood become numerous.

The single brood of Maine could be managed by deep fall ploughing of corn lands to break up the burrows and expose the chrysalides to the effects of fall rain and winter freezing. If a field is found badly infested it would be better to feed the corn green to stock than to allow the worms to mature and enter the ground. Infested ears should never be left in the field so the worns can leave them and crawl into the ground. When possible crush the worms found with the hand.

Any one wishing to look up this insect farther will find a condensed article in the Fourth Report of the United States Entomological Commission, p. 355, which is finely illustrated with colored drawings of the worms and moths.

THE CHINCH BUG.

Blissus leucopterus, Say.

Ord. Hemiptera: Subord. Heteroptera: Fam. Lygæidæ.

During the past season the following letters were received:

SCARBORO, Aug. 23rd, 1892.

PROF. BALENTINE:

MY DEAR SIR:—I sent you a small lot of insects from North Fryeburg, on Aug. 8th. I did not know how badly they were destroying the grass, but find they have spread over a large part of the town of Fryeburg, and that the farmers are at complete loss to know what to do to stop their spread. Any advice you can give them would be very thankfully received. I saw Brother B. W. McKeen on Saturday last, and told him what I had done. He was not aware that the damage was so great, as the bugs had not got to his section. Nathaniel Frye, Fryeburg Centre, John Batchelder, or John Hastings, North Fryeburg, would probably give you any information asked for.

Yours respectfully,
W. B. NUTTER.

SCARBORO, Maine.
PROF. F. L. HARVEY,
ORONO.

MY DEAR SIR:—Your very kind letter of the 24th at hand, and contents noted. The bugs you speak of were collected in a field in my own town. They have been found there in years past, and have done considerable damage at times. Can you give me their origin, habits and remedy, if there is any? They work in the grass roots, particularly Timothy hay, which they completely destroy. Thanking you for your information, I am

Yours very truly,
B. WALKER MCKEEN.

We answered Mr. Nutter's letter informing him that the specimens sent were immature forms of the Chinch-bug. We also wrote Mr. McKeen and asked him to secure for us some mature specimens of the insect so as to make its indentification positive, and the following letters were received in answer:

SCARBORO, Aug. 29, 1892.

PROF. F. L. HARVEY:

MY DEAR SIR:—Yours of August 26th at hand. In explanation of my sending the bugs to Prof. Balentine, will say I was on a business trip to Fryeburg and seeing the damage the bugs were doing I thought it the quickest way to find out what they were and what to do to destroy them, to send to headquarters. I did not know of anyone except Prof. Balentine to apply to. I have written B. Walker McKeen in regard to the matter and hope you will be invited to make a visit to North Fryeburg and make an investigation. I feel that the matter is quite serious and demands the attention of the State officials to keep it within bounds and to stamp it out if possible.

I have written to Simeon Charles at North Fryeburg to send you some of the bugs in alcohol, and have also written to Nathaniel Frye at Fryeburg Center, asking them both to give you any information they can in regard to the time of the first appearance of the pests, and also how extensive they have become.

Yours truly,

W. B. NUTTER.

SCARBORO, Maine.

PROF. F. L. HARVEY:

MY DEAR SIR:—Your letter received, and I have sent to Mr. S. C. Charles, North Fryeburg, for further samples. Think he has some of the full grown ones in alcohol. I find some of our Fryeburg farmers claim the bugs have been seen here occasionally for many years, twenty-five or thirty, at least.

B. WALKER MCKEEN.

NORTH FRYEBURG, Sept. 6, '92.

PROF. F. L. HARVEY:

DEAR SIR:—Brother Nutter wrote to me about those bugs that he sent you, saying you thought them to be the chinch-bug. I have got some in a vial which I shall send by this morning's mail. They have worked here for years. Friend Batchelder thinks they were here twenty-five years ago, but did but little damage. They are confined to the intervale wholly—have not been on the upland at all. They have not meddled with anything but herd grass and red top until this fall, when they got on the sweet corn; but have injured it but slightly. Hoping to hear from you and some remedy for the pest, I remain,

Yours truly,

SIMEON CHARLES.

AUGUSTA, Sept. 8th.

PROF. HARVEY:

MY DEAR SIR:—I forward you this letter from Brother Charles. Please acknowledge receipt. Make a *full* investigation. If you plan to go to Fryeburg let us know.

Yours very truly,
B. WALKER MCKEEN.

NORTH FRYEBURG, Sept. 8, '92.

BROTHER MCKEEN:

DEAR SIR:—Received your letter last night. I sent the bugs the 6th. They seem to be going in an easterly direction. I think from what I can learn they are on the Hobbs' intervale. Mrs. Hobbs' boy told me about his grass. No doubt they are at work on it. Hoping to find some remedy,

Yours truly,
SIMEON CHARLES.

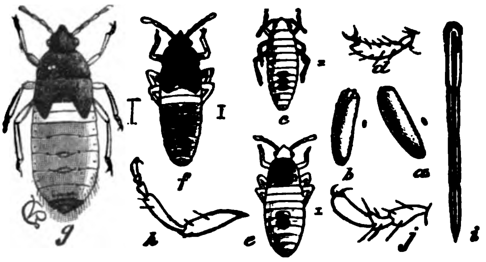
We were not able to visit the infested area without leaving class-room work at the college, and it was decided not to do so. Last fall we published a short article in the *Maine Farmer* announcing the occurrence of this insect in the State and suggested burning over the infested fields if possible. It will be desirable this season to learn the extent of the infested district, and we will be pleased to hear from all who may know of its occurrence even in small numbers upon their farms. That the insect may be known when seen, we give below a description of it in all the stages of its life history and suggest such remedies as have been tried in the West and South and have proved at all beneficial.

The information given below has been gleaned from the experiences of Riley, Forbes, Osborn, Gillette and others who have carefully studied the insect and remedies.

DESCRIPTION.

Eggs—Average length .03 in. elongate-oval, the diameter scarcely one-fifth the length. The top squarely docked and bearing four rounded tubercles near the center. Pale whitish and translucent when laid, but becoming amber colored with age, and finally the red parts of the enclosed embryo and the eyes show through. The eggs grow somewhat after being laid. See Fig. 5, a and b, which shows the eggs both natural size and magnified.

Fig. 5.



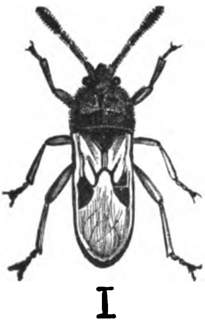
Chinch-bug, Larva, Pupa and Egg. *a* and *b*, eggs; *c*, young larva; *d*, tarsus of same; *e*, larva after first molt; *f*, larva after second molt; *g*, pupa; *h*, leg; *i*, beak or tubular mouth; *j*, tarsus of mature bug.

Larval stages.—The newly hatched larva (Fig. 5, *c*) is pale yellow, with simply an orange stain on the middle of three larger abdominal joints. The form scarcely differs from that of the mature bug, being but slightly more elongate; but the tarsi have but two joints (Fig. 5, *d*) and the head is relatively broader and more rounded, while the joints of the body are subequal, the prothoracic joint being but slightly longer than any of the rest. The red color soon pervades the whole body, except the first two abdominal joints, which remain yellowish, and the members, which remain pale. After the first molt (Fig. 5, *e*) the red is quite bright vermilion, contrasting strongly with the pale band across the middle of the body, the prothoracic joint [first behind the head] is relatively longer, and the metathoracic joint [third behind the head] shorter. The head and prothorax are dusky and coriaceous and two broad marks on the mesothorax [second joint behind the head], two smaller ones on the metathorax, two on the fourth and fifth abdominal sutures, and one at the tip of the abdomen are generally visible, but sometimes obsolete; the third and fourth joints of the antennæ are dusky, but the legs are still pale. After the second molt [Fig. 5, *f*] the head and thorax are quite dusky and the abdomen duller red, but the pale transverse band is still distinct; the wing-pads become apparent, the members are more dusky, there is a dark red shade on the fourth and fifth abdominal joints, and ventrally a distinct circular, dusky spot covering the last three joints.

Pupa—[Fig. 5, *6*]. In the pupa all the coriaceous parts are brown-black, the wing-pads extend almost across the two pale abdominal joints, which are now more dingy, while the general color of the abdomen is dingy gray; the body above is slightly pubescent, the members are colored as in the mature bug, the three-jointed tarsus is foreshadowed, and the dark, horny spots at the tip of the abdomen, both above and below, are larger.

Perfect Insect (Say's description).—Blackish, hemelytra white with a black spot. Body long, blackish, with numerous hairs; antennæ, rather short, hairs; second joint yellowish, longer than the third, ultimate joint longer than the second, thickest; thorax tinged with cinerous before, with the basal edge piceous; hemelytra (elytra) white, with a blackish oval spot on the lateral middle; rostrum and feet honey-yellow; thighs a little dilated; length less than three-twentieths of an inch.

Fig. 6.



Chinch-bug, The short line below shows natural length.

(Le Baron's description.)—Length 1 2-3 lines, or three-twentieths of an inch. Body black, clothed with a very fine, grayish down not distinctly visible to the naked eye; basal joint of the antennæ honey-yellow, second joint the same, tipped with black, third and fourth joints black; beak brown; wings and wing-cases white; the latter are black at their insertion, and have near the middle two short, irregular black lines, and a conspicuous black marginal spot; legs dark honey-yellow, terminal joint of the feet and the claws black.

LIFE HISTORY.

The *mature bugs* hybernate and may be found during the winter months under grass, dead leaves and rubbish, in the field and about thickets and timber adjoining the infested area. When the weather is warm enough in the spring they emerge from their hiding places and after finding suitable food plants for their young deposit their eggs. This probably occurs in May in Maine, but we have not had opportunity to determine when they begin to move. Each female is said to be capable of laying about five hundred eggs, and oviposition extends over twenty days. After the eggs are laid the bugs live some time and may do damage before they die. The eggs hatch in due time and the young pass through the larval stages described above and finally pass into the pupa stage. Bugs hatched in May become mature in July when after pairing eggs for a second brood are laid. In July there is usually a flight of the bugs to new fields and by this means the infested area may be greatly extended. The second brood reaches maturity in the fall and by cold weather is ready to seek winter quarters, completing the life history.

REMEDIES.

It is well known in the West and South where the Chinch-bug has done so much damage, that there are Chich-bug years, when climatic conditions combine to favor the rapid increase of this pest. A wet, backward spring and well distributed summer rains are known to destroy the eggs and young of the first brood and prevent the great increase of the second brood later in the season. The correspondence given above shows, that the pest has been in Maine in the infested district for a great many years, and it has not done serious damage until the past season. The conditions last year were probably a dry time while the eggs and young of the first brood were maturing and they survived in greater numbers than usual and gave rise to a much larger second brood. The coming season may be unfavorable for them and no great injury occur. The heavy rain fall of Maine will probably protect this State from such severe scourges as some of the Western States with less rain fall have suffered. The Chinch-bug seems very much adverse to fresh water baths and does not flourish in moist climates, upon very wet lands, or upon luxuriant crops that shade the ground and keep it moist.

The correspondence shows that the area is increasing and the matter is serious enough to demand careful attention. There should be concerted action upon the part of the farmers of the infested district. Whatever remedy is adopted to check this injurious insect will be of little avail unless it is a combined effect of the entire population in the infested district. One of the great difficulties is to secure concert of action. There are improvident farmers in every neighborhood who harbor weeds and injurious insects and will not destroy them, and there is no law to compel them. Public opinion and moral suasion are the only available levers. Below we suggest some remedial measures that may be applicable in Maine.

a, *Clean Culture.*—As the Chinch-bug hybernates under rubbish, etc., and those that survive the winter determine the number to lay eggs the following season; hence all rubbish and other material about the fields under which they can find shelter should be removed.

b, *Ploughing.*—When a grain field is badly infested it should be ploughed deep immediately after harvest before the bugs can migrate to adjoining crops. The land should be ploughed at least six inches deep and turned as nearly upside-down as possible. By this means a great many young bugs will be destroyed. We do not know whether the bugs have attacked grain fields in western Maine. This remedy would be applicable to a meadow as well as grain field if there was no objection to breaking it up. It is well to harrow and roll the land after ploughing to harden the surface and make it more difficult for the bugs to crawl out. If the bugs are found very numerous along the border of a meadow or in small patches in the field it would be well to plough these places early in the season and in two or three weeks sow to a late crop. Fall plowing is advisable, and if rubbish, straw, manure, etc., are placed on the field the bugs will crawl under it for shelter and be ploughed under. In plowing the use of a jointer is advised as it causes the surface of the ground to be more thoroughly buried.

c, *Burning.*—When the grass or grain stubble is dense enough or dry enough, the entire field should be burned over after harvest. If the bugs are found in a meadow in the fall, that you wish for grass the following season, and the stubble will not burn, then wind-rows of straw or swamp-hay should be put across the field. The bugs will seek shelter under them, when they should be burned early in the morning or late in the evening. The burning should be carried to all other places where they are known to be hybernating.

d, *Miscellaneous Remedies.*—*Early planting* and *heavy sowing* and good *fertilization* have been found important aids in the West to hold this pest in check. The Chinch-bugs only feed upon members of the grass family and rotation of grain with buckwheat clover, peas, beans, or other root crops would starve them out. In the West they sow strips of millet, of which the bugs are very fond, and after they gather upon it it is cut and the ground immediately plowed deep and rolled. Various insecticides have been used with more or less success, but they are omitted as perhaps of no application to checking the insect in Maine.

PLATE II.

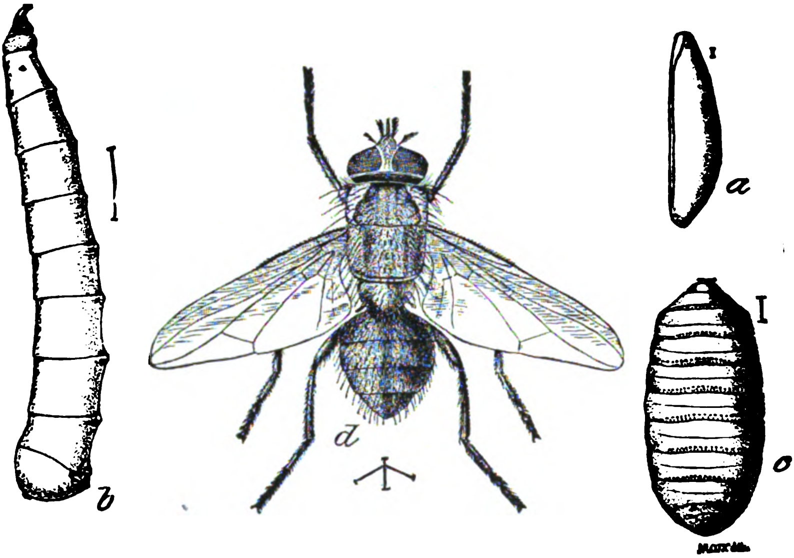


Fig. 1.

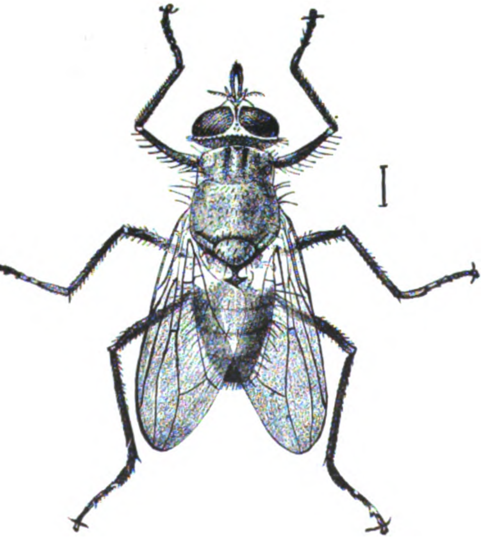


Fig. 2.

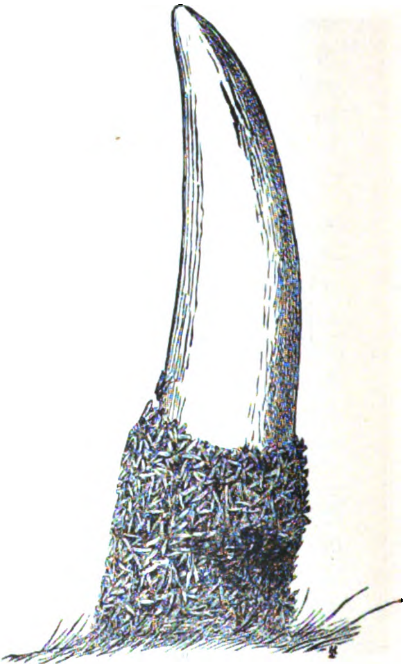


Fig. 3.

THE HORN FLY.

(Hæmatobia serrata.)

ig. 1. *a* Egg; *b* Larva; *c* Puparium; *d* Adult in biting position—enlarged. Fig. 2. Adult in resting ition—enlarged. Fig. 3. Flies in resting position at the base of the horn—reduced.

THE HORN FLY.

(*Hæmatobia Serrata, Robineau Desvoidy.*)

Ord. Diptera: Fam. Muscidæ.

We received the following letters regarding the occurrence of the Horn Fly in Western Maine:

AUGUSTA, Aug. 27, '92.

PROF. HARVEY:

MY DEAR SIR:—The Buffalo Horn Fly has been very troublesome in Fryeburg and vicinity, so much so that I have used Kerosene Emulsion (Weed formula) on our cows to protect them from their very sharp bites.

Yours very truly,

B. WALKER MCKEEN.

NORTH FRYEBURG, Sept. 6, '92.

PROF. HARVEY:

DEAR SIR:—We are having a visitation of the *Horn Fly*. Can you give us any information in regard to them? They do not appear to bite the cattle very much and do not annoy the horses at all, but they come in immense numbers and over a large territory at once.

Yours truly,

SIMEON CHARLES.

REMARKS.

This is a European species first noticed in this country in 1887, in the vicinity of Philadelphia. From that point it was spread both to the north and south but more rapidly southward, and now occurs from Canada to the Gulf, west to the prairie states and Texas. The first report of its occurance in Maine was September, 1882, in the vicinity of North Fryeburg, Western Maine. We have not observed it in the Penobscot Valley.

Below we give a condensed account of the life history and such remedies as have been suggested. Those who wish to study the insect more in detail will find it considered in Insect Life, Vol. 4, No. 2, Washington Government Printing Office, 1892, and in U. S. Agrl. Rept., 1889, page 345.

The flies resemble the house-fly in general appearance but are only about half as large. While feeding the wings are spread at an angle of about 60° (see Fig. d) and elevated.

LIFE HISTORY.

The reddish brown oval eggs Fig. a. are laid during the warmer parts of the day, singly and usually upon their sides upon the surface of the dung immediately after it is voided, the time of oviposition occupying about a minute. The eggs hatch and the larvae (Fig. 1 b.) descend intothe dung, remaining near the surface. When ready to transform the larvæ descend to the ground beneath the dung and enter it from a half to three-quarter of an inch, or if hard probably transform on the surface to the puparium. (Fig. 1 e.) In from ten to seventeen days from the time the eggs are laid the flies appear. (Fig. 1, d.) There are probably seven or eight generations annually in the middle or southern latitudes, but probably a less number in Maine. The fly makes its appearance in May or June and becomes most abundant in July and August, dwindling as cold weather approaches. It probably hybernates in the pupa and adult stages. The flies, when abundant and especially early in the season, collect about the base of the horns of animals to rest, hence the name.

DAMAGES.

The milk of milch cows is reduced in quantity and animals for the shambles rapidly loose flesh. The irritation due to the bites causes the animals, to rub themselves, producing sores. The flies bite the animals and suck the blood.

REMEDIES.

Protective Applications.—Almost any greasy substance wil keep the flies off for several days. Train oil or fish oil alone, or with a little sulphur or carbolic acid will keep the flies off for several days. Tallow has been used to good advantage. Common axle grease will answer nearly as well. These should be applied on the parts of the body most frequented.

Applications to destroy the fly.—A spray of kerosene emulsion directed upon a cow would kill all the flies it happened to touch. Dusting the cows with pyrethrum or some other dust insecticide, as tobacco, is recommended.

Applications of insecticides intended to check the pest by destroying the flies are hopeless against the immense swarms of them.

How to destroy the early stager.—Thoroughly lime the dung or spread it so it will dry. This will destroy large numbers of the larvæ. The most of the dung is dropped in places where the cattle collect after feeding, or at night and could be treated without much trouble.

THE TWO-SPOTTED MITE.

(*Tetranychus 2-maculatus, n. sp.*)

Ord. Acarina: Fam. Tetranychidæ.

We first noticed this species in Orono, Me., early in the spring of 1891, upon rose bushes exposed in a window at the Post Office. Since then it has spread to most of the plants in the window excepting geraniums, for which it seems to have an aversion. Mr. White whose rose bushes were infected thought the mites got on while his plant was loaned to a sick lady, but on inquiring we found no other plants were in the sick room at the time and the only possible source of infection was cut plants, which was improbable. In order to learn how general the distribution of this mite was in this region, we visited several houses in Orono, where house plants are kept, and in the majority of places found the mites doing considerable damage. Rejecting the positive statement of one party that these mites are the same as lice on hens and that her plants were all right until she set them out of doors and some lousy fowls infested them, we are inclined to think that the pest was introduced in Maine upon rose bushes and other plants purchased of a prominent dealer. The parties whose plants are infested in most cases had plants from this house and one party positively affirmed that the roses received were noticed to be infested when unpacked. Though great vigilance ought to be exercised by dealers that the plants they send out are in good health and not infested with injurious insects and fungi, yet they cannot always be held responsible, especially when the parasite is small and readily overlooked. Those who receive infested plants will have to discard them, or fight the pest by aid of known remedies.

Even experience has been no protection against the introduction of this mite for it has found its way into the large green houses of the country, also in the green house at the college in our own State and has been a source of much annoyance.

The mite is so small it is next to impossible to examine greenhouse stock or house plants carefully enough to prevent its introduction, and the custom of exchanging slips of plants for culture, so common in every neighborhood, aids greatly in its rapid dissemination.

The mite being firmly established in Orono and no doubt in many other places in the State, and having given so much trouble at various green-houses in the country and apparently never having been studied, described or figured by any of our entomologists; information regarding its life history, structure and control would seem to be of enough importance to warrant a careful study of the pest.

Having spent some time during the past two years investigating the nature of this species, the following preliminary notes upon it are humbly submitted, with the hope that they may aid in recognizing the form and put our florists upon their guard against it. We cannot hope to have been infallable in our observations, but have tried faithfully to record what we have seen.

We desire to acknowledge our indebtedness to Prof. L. H. Bailey of Ithaca, N. Y. for specimens of this mite, and also of the red spider for comparison, for a list of host plants and other data from his experience with it; to the Dingee & Conard Co., West Grove, Pa., for specimens of red spider and notes; to Peter Henderson & Co. for specimens of the mite on *Verbena* and notes; to Prof. Munson and citizens of Orono who from their abundance have supplied us without reluctance with all the specimens used for study.

CORRESPONDENCE.

After discovering this mite at Orono, Prof. Munson suggested that it was probably the same species that had given so much trouble in the green-houses at Ithaca, N. Y. We wrote Prof. Bailey and sent him a description of the mite. He responded: "Your description seems to match the mighty mite which we have. I do not know its name. Prof. Comstock does not know it." We wrote again for specimens for comparison and a list of food plants and in our letter called the species *Tetranychus 2-maculatus*, n. sp., as we had not been able to find any published description of it. Prof. Bailey responded with specimens upon Pepino, which proved to be the species found at Orono, also he stated: "This is the 'Verbena mite,' I suppose, of Henderson's Practical Floriculture." We responded to Prof. Bailey that the specimens sent were the same as the species found here, but whether they were the same as the *Verbena mite* referred to in Henderson's Practical Floriculture could not be determined by the vague description given in that work, which though it might serve the purposes of practical horticulture, was valueless, from an entomologist's standpoint.

Maine State College Experiment Station.

PLATE III.

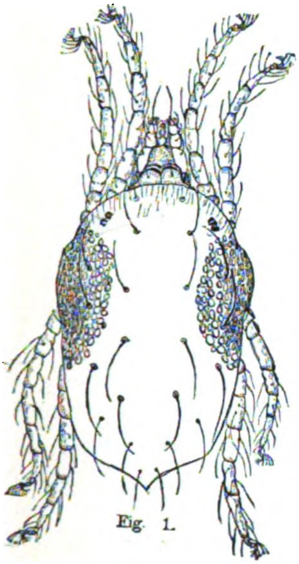


Fig. 1.

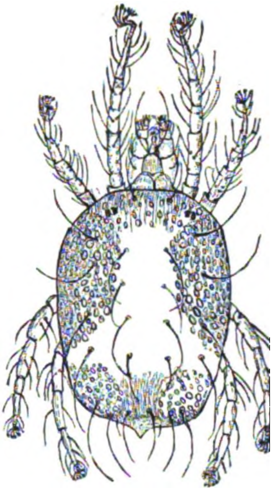


Fig 2.

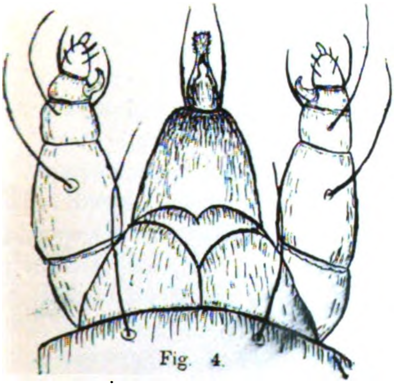


Fig. 4.

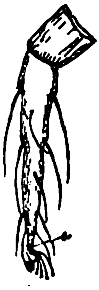


Fig. 3.

F. L. HARVEY, Del.

TWO SPOTTED MITE.

(Tetranychus 2-maculatus, n. sp.)

Fig. 1. Male mite magnified 100 times. Fig. 2, Female (probably) magnified 100 times. Fig. 3. F
much magnified *(a)* showing location of moveable joint. **Fig. 4.** Mouth parts and palpi magnified ab
250 times.

If you have seen what Henderson calls the "*Verbena mite*" and know it to be the same species as you sent me, that certainly is a clincher. Henderson's figure certainly is nothing like the mite in question. His figure is pointed in front while the mite we are considering is broadly oblong and rounded in front. Henderson's figure is 20 m m. (.8 in.) in length and he says it is magnified four hundred times. This would make the mite only .05 m m. (.002 in.), a *very minute microscopic form*. The mite we are considering is fully .5 m m. or .02 in. and *plainly* visible to the naked eye. Perhaps Henderson made a mistake and his drawing was only forty times magnified. We could believe this if he did not state that the *Verbena mite* "is so small that it cannot be seen by the naked eye." Henderson says it has the power of imbedding itself in the leaf, a habit which *certainly* does not apply to the species in question. Certainly Henderson has made a good many mistakes in his description or the species he examined was a different species. We believe it is best for entomologists to entirely ignore such loose, vague descriptions of insects as they are of no technical importance and only add confusion in defining species.

In the absence of any known technical description of this species, we concluded it would be better to describe it under the name *Tetranychus 2-maculatus*, n. sp., and have something *definite* than to leave the form without a name. Should it subsequently be shown that it has been described then our name drops and no harm is done. We will be most grateful for any evidence that this species has been described or named for we have no ambition to multiply synonyms.

Prof. Bailey responded: "I am aware that neither Henderson's description nor figures are applicable to the mite in question, and yet I think that he meant it, for I have known for some time that he has been troubled with the same species we have. Of course the reference, even if proved to apply to the mite, is of no scientific use, and I only referred you to it that you might perhaps gain a wider knowledge of its hosts and distribution. No doubt Alfred Henderson could send you specimens for determination."

Prof. Bailey kindly introduced us to Mr. Henderson and we requested specimens of the *Verbena mite* which proved to be the *same* species found at Ithaca and Orono.

Parties about Orono having stated *positively* that roses obtained from Dingee & Conard Co., West Grove, Pa., were infested by this mite, and we having seen the mite on rose bushes from that firm at one house and not on *any other* plants, and the mite having been first noticed at the Post Office in Orono on roses, we wrote Dingee & Conard Co. about the matter and below we give their reply.

WEST GROVE, PA., Jan. 21, '92.

FRANCIS L. HARVEY, ESQ.,
Orono, Me.

DEAR SIR:—Your kind letter to hand and contents carefully noted. We will gladly give you any information we can to assist you in this important undertaking. The insect or pest you describe which is so seriously affecting window and house plants through your locality, we must say we know nothing of. We have not come in contact with such a pest in any of our houses or on our plants like this, and can assure you it did not originate with us, or we would know something of it. Such pests are more frequently found among soft wooded plants. We have but little of this class of stock in our establishment and consequently are troubled but little with any insect. We are sometimes visited with the *red spider* on our roses, but such is a very rare occurrence, and when thus affected it is not at all a serious matter to get rid of them, syringing them twice a day being a very satisfactory remedy and always effective. We find when plants are kept in a perfectly healthy condition there is little or no danger of the pest or insect of any kind attacking them. The *red spider* can hardly be termed a pest. It is with us but a mild disease caused by too warm and dry an atmosphere. We shall be glad if this information is of any advantage to you and will gladly give you any other information we can.

Very truly yours,
THE DINGEE & CONARD CO.

We wrote again to Dingee & Conard Co. for specimens of what they regarded as the *red spider*, and the species sent was the same as the one found here so far as we could tell from a careful microscopic examination. We also requested Prof. Bailey to send us specimens of the *red spider*. He said they had none in their houses but one of his men procurred some from another source which we were unable to separate from the Cornell green-house specimens only by their being redder in color.

We must confess that we are very much confused by the above data. Henderson, Bailey and Munson, who have had considerable experience with this mite are decided in their opinion that it is entirely different in its habits from the *red spider* and will not

COLLEGE OF

yield to the same treatment. If the specimens sent us by Dingee & Conard Co. and Prof. Bailey's men, were the genuine *red spider*, we are forced to conclude that in this mite we have a species scarcely separable from the *red spider* by its structure but differing very much from it in habit. If called upon to decide from the structure alone we would be compelled to call it a form of the polymorphous species *Tetranychns telarius*, L., or *red spider*.

No importance can be attached to color in this species nor in the *red spider* for in both it is variable with the food plant and also with the age, each molt disclosing a different shade. All we have left upon which to construct this species is the marked physiological differences, noted by Henderson, Bailey and Munson. Can it be possible that it is a case of adaptability—a form of the *red spider* that has changed its mode of living to suit new conditions? Such cases are not uncommon among insects. We leave it an open question for a want of sufficient data. The published descriptions and figures of the *red spider* are so meagre and so lacking in minute detail that it would be very difficult to determine from them whether specimens in hand belonged to that species. Even the published characters of the genus Tetranychus are faulty on account of imperfect microscopical examination.

GENERAL DESCRIPTION.

Perfect insect—length of full grown specimens, including palpus, .4 to .6 m m.; breadth, .25 to .3 m m.; thickness .175 to .2 m m. Broadly oval, about two thirds as broad as long. Broadest in the anterior third of the body back of the eyes, where the sides are somewhat swollen. General color when young or free from food, pale orange or greenish yellow, becoming yellowish orange or orange with age. The *majority* of the specimens have a dark spot on each side as shown in Fig 1. due to food contents. These spots first appear, in young specimens which have six legs, as scattered brownish or greenish spherical bodies that look like oil drops. These increase in number with age and are sometimes arranged in three groups. Finally they merge into a single mass as shown in Fig. 1. In older specimens dark patches are found in the anterior and posterior portions of the body, (see Fig. 2), or in full fed specimens the body is entirely dark colored. The shade seems to vary with the color of the food, from the yellow orange and brown to green, dark green or black; those feeding on calla, especially, a deep dark green.

The palpi and legs, especially in older specimens, are tinged with orange. The young are smaller, paler and have only six legs. Body and legs clothed with stout bowed hairs. There are four rows of about five hairs each on the dorsal aspect of the body. Eyes carmine, composed of two facets placed one ahead of the other, and obscurely bilobed. Palpi about one-fourth the length of the body. Eggs spherical, diameter variable, length 75 to about 110 micromillimetres, glassy, scattered and loosely attached to the web. Web delicate, filmy, stretched loosely over the surface of the plant, principally on the under surface of the leaves, though sometimes the upper surface is covered, often stretching across from leaf to leaf, or from the stem to the petioles. They are more plentiful along the principal veins, especially where they join the petiole, also in the angle where the petioles join the leaf, being plainly visible to the naked eye and giving a glassy or silvery reflection from the surface covered. Fibers of the web are from 10 to 20 micromillimetres in diameter but apparently composed of smaller fibrils. The web does not seem to be geometrically constructed as that of the spider. The mites walk freely over the surface or secrete themselves beneath it. The feet are long and the movement of the mite slow and spider-like.

MICROSCOPIC CHARACTERS.

The body, legs and mouth parts magnified five hundred diameters appear finely corrugated, the ridges and furrows often less than .001 m m. wide. On the under side of the body toward the posterior end, is an elevation in which the corrugations are much wider and zig-zag. This probably marks the location of the spinerets and anal opening. The stout hairs clothing the body are in full grown specimens often one-fourth the length of the body, or about .15 m m. The eye facets are about .05 m m. in diameter. The hairs on the legs are about four times as long as the legs are wide where they occur, or sometimes fully .1 m m. long. The legs are composed of seven joints exclusive of the moveable foot portion. The seventh joint is short, a little longer than the three segments of the foot combined and has but little movement with the sixth joint. The foot portion is composed of three joints, the proximal two about equal in size, same length but wider than long; terminal segment curved and ending in a two claws; each fork ending in a brush of about three stiff, pointed, spreading hairs. At the back on the end of the preceeding segment arise four stiff bowed hairs over .02 m m. long ending in hemispherical swellings which are broadest at the end and flat or slightly rounded. These hairs curve in the same direction as the claw and extend considerable distance beyond it. There is a free joint between the seventh segment of the leg and the foot portion. The two joints and the claw make up the moveable parts. When walking on glass or any smooth surface the mite puts the paw out behind as one would bend the hand backward at the wrist, resting on the end of the seventh joint, the claw and the end of the four stiff hairs, the terminations of which are put squarely down upon the surface. These hairs with enlarged ends may be used for spinning as suggested by Murray, but one cannot watch the movements of this mite without believing they are adapted for locomotion.

According to Murray, the stiff hairs on the feet of *Tetranychus telareus* (the *red spider*) are attached to the claws, and he has so represented them in a cut (Economic Entomology, p. 97). In this species they are appendages of the small joint of the foot next to the claws. Also he says these hairs have globular terminations and so figures them. In our specimens the hairs end in trumpet-mouth like terminations, disc-like at the ends and are put flat on the surface in locomotion. Prof. Riley in *T. 6—maculatus*, (U. S. Agrl. Report, 1889, p. 111), represents the hairs as originating from the back of the claws and as hooked at the ends. The mouth-parts of the *red spider* as shown by Murray, and those of *T. 6 maculatus*, Riley, differ from those of our species.

According to the characters laid down for the genus *Tetranychus* by Murray, there should be only seven joints in the legs. We are at a loss to know just what was included by him in the terminal or tarsal joint. There are seven segments in the leg above the moveable joint in the foot region spoken of above. If the three moveable elements below this joint constitute a distinct segment, then there are *eight* joints to the leg. If the fixed short segment above the moveable joint is concluded in the terminal segment, then there are only *seven* joints to the leg. The location of the joint is shown in Fig. 3, a. Extending from the front of the carapace are the mouth parts, made up of the palpi, rostrum or beak, proboscis and mandibles. The *palpi* (see Fig. 4) are seven jointed. The terminal joint is short, about .008 m. m., with parallel sides and an obtuse rounded end, twice as long as broad. Second joint is broadly conical, somewhat broader at the base than long, length about .015 m. m. at top and .025 m. m. at base, bearing on the inner face about four bristles, see Fig. 4. The third joint is not more than half as long as broad (about .015 m. m. by .03 m. m.) bearing on the inner side a claw about .02 m. m. long, curved toward the face of joint two, which bears the bristles. There is a free motion between segments two and three, and joints one and two are moveable and opposed to the claw on joint three, making nipping jaws. The structure of the end of the palpus of this species has a striking resemblance to that of *T. 6—maculatus*, Riley figured in U. S. Agrl. Report, 1889, pl. II., though the third short joint bearing a claw seems to be absent, or not shown in his drawing. The *rostrum* or *beak* is composed of three segments, (see Fig. 4) the basal one composed of two parts, broad at the base and rounded in front, and at the carapace reaching beyond and covering the base of the palpi. The second joint is short and emarginate in front, terminal segment tongue shaped, obtuse and emarginate in front. Originating beneath the rostrum and extending forward beneath the palpi are two stout hairs. The basal portion of the proboscis is covered by the beak of the carapace. The visible portion is composed of three joints. The basal is broadest and oblong; the terminal one slender, rounded in front and bearing at the edge two short spines and near the end numerous slender spines. The details of the mandibles we could not make out clearly but think they are rounded and plain on the outer margin, bearing at the end a lobe which projects beyond the end of the proboscis.

Greenish black spots are usually found on the leaves of plants affected by this mite. Probably this is the reason why Henderson called the disease by the inappropriate name "Black Rust." It is commonly believed that these dark spots are formed from juices of the plants that have exuded from punctures made by the mites and have dried. A careful microscopic examination proved them to be small usually globular masses from .1 m m. to .175 m m. in diameter and composed of spherical elements from .025 to .035 m m. in diameter. These spherules are clear with granular contents, or greenish with a darker centre. A careful comparison of them with the contents of the body of the mites proved that they were excreta. These yellowish, or black balls are often found attached to the fibres of the web in *mid air* between the points of attachment of the web where it stretches across from leaf to leaf or from stem to leaf. This could not possibly occur if they were exudations from punctures. The web running over the surface and dotted here and there with these yellow and black excreta reminds one of aminute erysiphe in different stages of development.

HOST PLANTS.

From the table of host plants given below, it will be seen that this mite is a general feeder, attacking a wide range of both glabrous and hirsute plants belonging to a wide range of families. This list is no doubt far from complete, as no great pains has been taken to make it exhaustive. Should this mite prove capable of living out of doors it would become a double terror to horticulturists. It at present is found out of doors only in rare instances, and there is no evidence that it is as Henderson suggests, common in gardens, or the same as that which produces roughness to particular parts of cherry, plum and peach trees. Our experience does not warrant the belief that it attacks *especially* plants of lessened vitality. These mites, like plant lice, live by sucking the juice of plants, and are pretty good judges of proper feeding grounds. They are not likely to turn aside from a healthy juicy plant to one of the same species that is sickly and lacking in juices. They are small and would escape observation until a sickly condition was produced in the host plant and attention directed to it. We believe that instead of especially attacking sickly plants they are the cause of lessened vitality. The list of host plants given below shows that the mite has no special preference for pubescent plants, in fact, some of the worst cases of attack we have seen were upon glabrous species. Munson and Harvey are authority for the occurrence of the mite at the Maine State College green-houses and at private houses in Orono and vicinity; Prof. L. H. Bailey for the occurrence of the mite in the green-houses at Cornell College, Ithaca, N. Y.; Henderson for its occurrence in their green-houses, New York City; Dingee & Conard Co. for its occurrence at West Grove, Pa.

HOST PLANTS.

Order.	Common Name.	Techcical Name.	Authority.	Remarks.
Ranunculaceæ.	Jackman's Clematis.	Clematis Jackmanni.	Munson, Harvey.	College green-houses only.
Resedaceæ.	Mignonette.	Reseda odorata.	Munson.	" " " "
Caryoplyllaceæ.	Pink.	Dianthus caryoplyllus.	Munson.	" " " "
Malvaceæ.		Malope grandiflora.	Bailey.	
"	Indian Mallow.	Abutilon species.	Bailey.	
Geraniaceæ.	Stork's Bill.	Pelargonium species.	Henderson.	Plants of this family have not been attacked at the College nor in Orono.
"	Canary Bird.	Tropæolium peregrinum.	Munson.	
Leguminosæ.	Beans.		Bailey, Munson, Harvey.	At Orono beans out of doors badly affected.
Rosaceæ.	Ordinary Roses.		Havey, Durgee & Conard Co.	
"	Polyantha roses.		Bailey.	
"	Apricot.		Bailey.	Growing out of doors, near green-house.
Lythraceæ.	Cuphea.	Cuphea Llavæ.	Henderson.	
Onagraceæ.	Godelia.	Œnothera species.	Bailey.	
"	Ladies' Eardrop.	Fuchsia species.	Harvey.	Plants in Orono badly infested.
Passifloraceæ.	Gronadella.	Passiflora edulus.	Bailey.	
Cucurbitaceæ.	Cucumbers.	Cucumis sativus.	Munson, Bailey, Harvey.	
"	Musk Melon.	" Melo.	Munson.	College grounds.
Rubiaceæ.		Manettia species.	Henderson.	
"		Bouvardia species.	Henderson.	
Compositæ.	Feverfew.	Leucanthemum Parthenium.	Harvey.	Plants in Orono.
"		Chrysanthemum	Harvey, Henderson.	
Scrophulariaceæ.	Monkey-flower.	Mimulus tigricoides.	Munson.	
"	Musk Plant.	Mimulus Moschatus.	Munson.	
"	Slipper Flower.	Calceolaria species.	Henderson.	
Acanthaceæ.	Thumbergia.	Thumbergia alata.	Bailey.	
Verbenaceæ.	Verbena.	Verbena species	Henderson, Bailey, Harvey.	
		Lantana species.	Henderson.	
Labiatæ.	Sage.	Salvia splendens.	Munson.	
Borraginaceæ.	Heliotrope.	Heliotropum sp.	Henderson.	
Convolvulaceæ.	Cypress-vine.	Quamoclet vulgaris.	Munson.	
"	Moon-flower.	Ipomea noctophylon.	Munson.	
"	Morning Glory.	Pharbitis species.	Bailey.	
Solonaceæ.	Tomato.	Lycopersicum esculentum.	Munson, Bailey, Harvey,	
"	Pepino.	Solanum muricatum.	Bailey, Munson.	
"	Egg Plant.	Solanum melongena.	Bailey, Munson.	
"	Pepper.	Capsicum annuum.	Munson.	
"		Petunia species.	Harvey, Henderson.	
"	Wedding Bell.	Brugmansia arborea.	Harvey.	Very badly infested.
Euphorbiaceæ.	Castor Oil Plant.	Ricinus communis.	Harvey.	Badly infested.
	Hop.	Humulus lupulus.	Munson.	Out of doors.
Araceæ.	Calla.	Calla species.	Harvey.	
Smilaceæ	Boston Smilax.	Myrsiphyllum asparagoides.	Bailey.	Very bad.
Liliaceæ	Easter Lily.	Lilium Harrisii	Harvey	

REMEDIES.

The experience of Bailey, Henderson and Munson would lead one to conclude that there is no remedy at present known that is entirely effective.

Henderson writes us that one of the best remedies is Fir Tree Oil, and another very good one is Cole's Insect Destroyer but the cost of the latter almost prohibits its being used in large quantities. Prof. Bailey has had considerable experience with Fir Tree Oil but does not find it entirely satisfactory, though of considerable value.

Prof. Munson says he has used an alcoholic tincture of Pyrethrum and finds it quite satisfactory. There is a general belief that the red spider is readily destroyed by a copious use of water and will not flourish in a moist atmosphere. The impression of those who have had most experience with this mite, is that it may be very bad in a moist atmosphere. Prof. Munson relates one instance of a cucumber house where the plants were badly infested though the atmosphere was kept quite moist. We believe, however, that spraying the plants frequently with water, would help hold them in check by reducing the temperature. They seem to enjoy a high temperature.

Henderson believes an ounce of preventive is better than a pound of cure and if the plants are kept in good health they will resist the disease. He has frequently noticed that where plants become pot-bound it would make its appearance while others potted at the same time and shifted as the occasion required would be perfectly free from it, thus showing that the disease is altogether the result of imperfect conditions of growth. We have commented upon this elsewhere under the head of host plants.

Fir Tree Oil can be obtained from August Rölker & Sons, 136 W. 24th St., N. Y., at a cost of $3.25 per gallon, in five gallon lots, less ten per cent. for cash with order. It should be diluted about one hundred times with water and applied with a syringe or atomizer.

Alcoholic Tincture of Pyrethrum—Digest one part by weight of Pyrethrum (Dalmation Insect Powder) in four parts of commercial alcohol and apply the undiluted tincture to the foliage with an atomizer.

Cole's Insect Destroyer—Mr. Henderson says: "Is sold in half pint cans, price 50 cents. It is already for applying with an atomizer, such as is used for perfumery. Being very powerful a little is sufficient. For house plants we know of no better insecticide."

CUT WORMS.

We publish the following correspondence not to criticise Mr. Fowler but to call attention to the loose way in which names are applied to insects and the importance of being certain about the names of insects doing injury before applying remedial measures. We were glad to receive Mr. Fowler's letter for it offered us the opportunity of explaining the restricted use of the term cut-worm by entomologists and that it is not used in the brood sense that includes any kind of worm found feeding upon the roots of farm crops. We will always be pleased to answer questions or explain differences of opinion.

CORRESPONDENCE.

SEARSMONT, ME., Sept. 9, '92.

MR. F. L. HARVEY:

DEAR SIR:—Part V of Ag. Rept. is at hand and in reading about cut-worms I think my experience may help some one. Cut-worms used to trouble my beets and corn. I noticed when green manure was used in the spring and left uncovered for any length of time—say half a day—a yellow fly such as one sees around manure piles used to fly around and on the manure in the drills, and produce an abundant crop of dark gray or brown or nearly black cut-worms. When manure was hauled from *dark* barn cellar and *immediately covered* found no cut-worms. So by keeping manure in cellar until wanted for use and keeping cellar dark so no flies would stay there and covering manure immediately I am clear of the pest. Whoever uses barn-yard manure, or manure that is stacked will find plenty of them. For proof examine droppings of cattle in pasture and around buildings and enough of these pests will be found at some stage in the manure. Hoping this may help some as a suggestion I send it.

Very truly,
MOSES A. FOWLER.

The following is our answer somewhat changed and extended for publication:

ORONO, ME., Sept. 23, '92.

MR. MOSES A. FOWLER:

DEAR SIR:—You and I have different ideas about cut-worms. According to my understanding the term cut-worm is *restricted* by entomologists to the larval or caterpillar stage of Hawk Moths such as I have figured in my Report, Figs. 4, 6 and 7 and is not used in the broad sense suggested by you, which would include all worms that eat or cut the roots or other parts of farm crops.

The yellow insects to which you refer belong to the *Order Dieptera* or *two-winged flies*, related to the house-fly and in their worm stage should be called *maggots*. Our root crops are often affected by maggots, as the maggot of the Radish Fly and that of the Onion Fly, but these do not cut off the plants like cut-worms but bore into the roots. The moths of cut-worms lay their eggs near the roots on grass in meadows and pastures and *not* in manure piles. The white *grubs* found in manure are the larvæ or worm stage of beetles (Coleoptera) like the May Beetle and related species. Though the housing of manure is to be recommended to prevent leaching and no doubt if properly protected would be less infested with manure loving larvæ, but cut-worms do not seek such a nidus for their eggs.

Your crops were probably affected by the maggot of some fly, or more probably the grub of some beetle, or possibly by genuine cut-worms that had crawled from adjoining meadow or pasture lands. It may have been the grub of the *Three-toothed Aphodius* mentioned in my Report, 1891, p. 199, as cutting corn. The sources of insect pests are so many, and the species that feed upon our farm crops so numerous, it is important that each case of injury be carefully examined.

If you will send me in a small box the worms you call cutworms I will take pleasure in examining them and tell you whether they are correctly named.

Very truly yours,
F. L. HARVEY,
Entomologist for Station.

REPORT OF METEOROLOGIST.

PRESIDENT FERNALD, METEOROLOGIST TO THE STATION.

MAINE EXPERIMENT STATION.

Lat. 44°, 54', 2", N. Long. 68°, 40', 11", W.

In presenting my fourth annual report as Meteorologist to the Maine Experiment Station, I desire to state definitely as in former reports, that the object sought "is not so much the observing and reporting of general atmospheric phenomena as the careful study of the special meteorological conditions which are more or less intimately connected with practical agriculture."

In order to secure trustworthy results, it is necessary that observations directed toward a solution of any problem in Meteorology be continued through a series of years. Accordingly, in presenting my first report, a plan of summarizing observations and deducing conclusions was adopted, which should be suited to the presenting of like data covering any number of years.

The present report is made in accordance with the prearranged plan and includes in addition to the results of the three preceding years those obtained from about eleven thousand observations taken during the year 1892.

The deductions, therefore, of this report are based upon more than forty thousand independent observations.

The instruments have remained unchanged in position during the four years for which this report is made, and the greater part of the observations have been taken by one observer.

In presenting the arrangement of instruments and other necessary descriptive or explanatory data, I draw freely from my report of last year, simply adapting its statements so far as needful to the more extended period of time.

The most of the instruments employed were manufactured by H. J. Green, of Brooklyn, N. Y. Mr. Robert H. Fernald of

Orono, has been observer during the four years that this work has been carried on. In this report the results of observations made during the years 1889, 1890, 1891 and 1892, are combined.

The several problems considered appear in definite order, in the following pages. The first to which attention has been given, is a determination of the percentage of moisture in forest as compared with that in open field.

The arrangement of instruments for this investigation is herewith submitted.

Hygrometer No. 1 is placed in a wooden stand constructed for thermometrical instruments and located in the open field remote from buildings. Hygrometer No. 2 also is enclosed in a wooden box, perforated to allow a free circulation of air, and located also in the open field. Hygrometer No. 3 is also enclosed in a perforated box attached to a tree in a moderately dense forest. Hygrometer No. 4 is placed in a similar box attached to a tree in a portion of the forest a little more open than that in which No. 3 is located, but near which is a running brook except during the driest part of the summer.

Each hygrometer is about four feet above the surface of the ground. Readings are taken three times daily, at 7 A. M., at 1 P. M., and at 7 P. M., local time.

Observations were commenced April 5, 1889 and they have been continued through the growing seasons of 1889, 1890, 1891 and 1892.

The monthly averages are given in the following tables on the scale of 100.

PERCENTAGES OF MOISTURE.

HYGROMETER NO. 1.—IN OPEN FIELD.

	1889.			1890.			1891.			1892.			
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	Mean
April	81	53	66	74	50	58	85	61	67	74	47	57	64
May	84	60	71	81	62	74	82	57	67	78	63	67	71
June	88	67	81	83	72	75	83	62	71	86	69	74	76
July	85	65	75	85	74	79	87	61	72	84	57	69	74
August	95	70	80	90	63	77	89	67	83	92	70	8,	80
September	93	68	83	93	76	85	92	67	84	97	61	81	82
October	94	66	79	90	62	79	90	63	80	86	64	76	77
Mean results	89	64	76	85	66	75	87	63	75	85	62	72	75

HYGROMETER NO. 2.—IN OPEN FIELD.

	1889.			1890.			1891.			1892.			
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	Mean
April	78	52	65	70	46	56	84	62	70	74	50	63	64
May	80	53	68	78	61	74	80	55	68	78	63	70	69
June	84	66	74	78	68	75	82	62	73	84	67	73	74
July	79	60	69	80	63	71	86	62	75	82	55	67	71
August	87	67	75	88	62	73	87	65	80	90	68	81	77
September	91	60	81	91	67	83	91	67	85	92	60	81	79
October	93	66	81	91	62	79	91	65	82	83	64	77	78
Mean results	85	61	72	82	61	73	86	63	76	83	61	73	73

HYGROMETER NO. 3.—IN FOREST.

	1889.			1890.			1891.			1892.			
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	Mean
April	81	62	60	78	61	69	90	73	77	83	63	71	72
May	83	63	73	87	74	81	86	68	75	86	71	76	77
June	89	80	84	87	77	82	88	81	84	91	78	82	73
July	94	86	91	93	85	83	92	80	85	92	74	81	86
August	91	89	93	94	80	84	95	81	88	96	85	89	89
September	96	88	92	96	87	92	95	81	92	96	77	88	88
October	96	90	90	96	86	90	92	77	86	90	80	85	88
Mean results	90	80	85	90	79	83	91	77	84	91	75	82	82

HYGROMETER NO. 4.—IN FOREST.

	1889.			1890.			1891.			1892.			
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	Mean
April	83	65	77	79	60	71	91	74	82	84	65	75	75
May	89	66	80	88	73	84	87	69	78	87	74	77	79
June	92	81	86	89	77	84	90	74	82	92	79	84	84
July	93	79	87	91	79	85	93	79	86	94	72	80	85
August	95	86	91	91	78	85	96	78	90	97	86	90	89
September	96	83	90	97	86	92	96	79	92	95	76	87	88
October	96	80	90	94	80	89	92	76	87	91	79	86	87
Mean results	92	77	86	90	76	84	92	75	85	91	76	81	84

Percentages of Moisture.

RESULTS FOR 1889, 1890, 1891 AND 1892, COMBINED.

	7 A. M.	1 P. M.	7 P. M.	Mean
Hygrometer No. 1, in open field.	86	64	75	75
" " 2, " " "	84	62	73	73
" " 3, in forest,	90	78	84	84
" " 4, " "	91	76	84	84

Regarding the mean results from hygrometers Nos. 1 and 2 as indicating percentages for the open field, we have the following summary of results:

	7 A. M.	1 P. M.	7 P. M.	Mean
Percentages of moisture, open field,	85	63	74	74

Regarding the mean results from hygrometers Nos. 3 and 4 as indicating percentages for forests only moderately dense, we have the following summary results:

	7 A. M.	1 P. M.	7 P. M.	Mean
Percentages of moisture, forest,	91	77	84	84

Comparing results, open field and forest, we have excess of moisture in forest above that in open field expressed in percentages.

7 A. M.	1 P. M.	7 P. M.	Mean
6	14	10	10

It thus appears from observations covering the period of growth of four years, that the excess of moisture in forest above that of open field in the morning, amounts to but 6 per cent., while in the middle of the day it rises to 14 per cent., and at night-fall drops down to 10 per cent., and that the mean excess for the day is 10 per cent. In a very dense forest the percentage of excess would undoubtedly rise much higher. The presence of patches of forest in any region exerts a marked influence on the hygroscopic conditions of the atmosphere, and this condition, in turn, is an important factor in the growth of vegetation.

SOIL TEMPERATURES.

In this investigation a knowledge of the temperature of the soil at different depths, during the growing season, is sought, and ultimately the law which represents the rate of change of temperature at different depths.

The periods covered by the experiment are from May 1 to Nov. 1, 1889, from April 1 to Nov. 1, 1890, 1891 and 1892, with thermometers placed in the soil to the depths of 1, 3, 6, 9, 12, 24 and 36 inches.

The thermometers have been allowed to remain in place during the winters intervening between the periods of observation.

Their location is in the open field, near hygrometer No. 2, in the tract of land assigned to the Station for experimental purposes and devoted to farm experiments. The character of the soil is regarded, therefore, as representative of that on which the field experiments by the Station are carried on.

A summary of results for the four seasons by monthly averages is given in the annexed tables.

SOIL THERMOMETERS—1889.

	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
May..................	51.77	62.92	59.20	51.50	60.33	59.70	52.92	55.21	57.04	51.49	53.31	55.44	52.46	52.15	53.21	48.84	49.06	49.01	46.28	46.42	46.48
June..................	61.94	71.54	67.56	61.38	69.62	67.76	61.85	68.43	65.35	62.07	62.27	63.51	61.26	61.10	61.79	57.23	57.43	57.41	54.36	54.54	54.52
July..................	63.41	72.10	68.89	63.10	70.86	69.54	64.25	66.51	67.48	64.93	65.15	66.27	64.30	64.02	64.29	60.99	61.14	61.03	58.50	58.62	58.57
August..................	61.18	69.59	66.90	61.75	68.91	68.01	62.90	64.83	66.01	59.82	63.88	65.01	63.31	63.10	63.31	60.96	61.10	60.97	59.16	59.31	59.23
September	57.11	61.56	61.45	57.74	63.01	62.89	59.47	60.25	61.29	60.29	60.20	60.93	60.30	60.21	60.04	59.42	59.51	59.36	58.40	58.51	58.37
October...............	42.80	43.59	45.50	43.80	47.31	46.72	46.06	46.48	47.12	47.21	46.97	47.32	48.17	47.83	47.85	50.63	50.65	50.54	51.66	51.66	51.61
Mean................	56.37	63.55	61.58	56.54	63.34	62.44	57.91	60.28	60.71	57.97	58.63	59.75	58.30	58.06	58.41	56.34	56.48	56.39	54.84	54.73	54.79
Mean temperature for six months	60.50°			60.77°			59.63°			58.78°			58.26°			56.40°			54.79°		

SOIL THERMOMETERS—1890.

	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
April	33.74	40.35	36.89	36.53	38.12	37.11	34.32	34.55	35.13	33.56	34.09	34.29	34.57	34.55	34.75	34.81	34.83	34.95	35.31	35.39	35.37
May	50.38	54.80	51.53	47.63	54.67	53.40	49.40	50.26	51.49	49.29	49.27	49.72	48.80	48.68	48.82	45.72	45.55	45.84	43.27	43.72	43.77
June..	56.06	60.05	59.68	55.91	60.44	60.07	56.11	56.78	57.55	55.85	55.95	56.32	55.99	55.95	55.82	53.52	53.18	53.27	50.85	50.94	50.96
July	62.82	64.69	64.03	62.66	66.93	66.81	65.91	64.11	64.87	62.85	62.95	63.88	62.70	62.60	62 78	58.77	58.84	58.77	56.25	56.28	56.34
August...........	61.80	68.20	67.28	62.15	67.60	67.41	63.69	65.08	66.26	63.91	64.16	64.83	63.87	63.84	63.91	61.72	62.09	61.34	59.43	59.40	59.39
September	56.51	59.83	59.43	57.44	58.98	59.62	58.21	56.56	59.34	58.36	58.30	58.59	58.73	58.58	58.56	58.15	58.43	58.37	57.78	58.05	57.65
October	45.37	47.17	46.67	45 77	47.16	46.76	47.09	47.10	47.23	47.40	47.32	47.66	48.81	48.72	48.59	51.06	50.97	50.86	52.07	52.04	52.00
Mean............	52.38	56.44	55.07	52.58	56.29	55.88	53.54	53.78	54.55	53.08	53.15	53.61	53.35	53.27	53.32	51.97	51.99	51.9[illegible]	50.70	50.83	50.78
Mean temperature for seven months,	54.63			54.92			53.96			53.26			53.31			51.96			50.77		

SOIL THERMOMETERS—1891.

	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
April............	37.70	42.48	42.34	37.69	42.32	42.41	39.03	39.81	41.40	37.64	37.68	39.93	38.80	38.69	38.58	36.87	36.96	37.01	37.46	37.53	37.53
May..............	46.54	54.03	52.93	54.31	53.73	52.87	47.49	49.27	51.24	47.83	48.22	49.36	47.64	47.63	47.90	45.00	45.14	45.20	43.78	43.49	43.50
June.............	59.18	65.42	64.53	59.10	64 80	64.21	59.43	60.40	61.73	50.23	58.96	59.67	58.79	58.37	58.60	54.00	54.12	54.11	51.25	51.35	51.37
July.	62.70	68.59	67.44	62.78	67.56	67.10	63.08	64.23	65.18	63.17	63.18	62.85	62.39	62 14	62.44	58.16	58.25	58.26	55.75	55.82	55.83
August...........	62.45	69.07	67.46	62.59	68.03	67.45	63.98	64.97	66.62	63.93	63.99	64.99	63.80	63.59	63.91	60.72	60.83	60.76	58.66	58.75	58.37
September.......	58.82	62.88	62.41	59.00	62.85	62.55	60.43	60.99	62.00	60.57	60.48	61.21	60.77	60.60	60.78	59.67	59.70	59.65	58.53	58.61	58.36
October	46.03	48.78	47.94	46.20	48.86	48.22	48.20	48.54	48.81	48.78	48.57	49.17	50.02	49.86	49.77	52.74	52.67	52.53	53.61	53.58	53.59
Mean............	53.35	58.75	57.86	54.52	58.31	57.83	54.52	55.46	56.71	54.45	54.44	55.34	54.60	54.41	54.56	52.45	52.52	52.50	51.29	51.30	51.49
Mean temperature for seven months,	56.65°			56.89°			55.56°			54.74°			54.52°			52.49°			51.36°		

SOIL THEMOMETERS—1892.

	1 inches.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o
April............	38.07	42.65	42.86	38 39	41.17	42.16	39.46	39.85	41.02	38.66	38.93	40.19	39.15	39.08	39.88	37.72	37.85	37.87	37.25	37.30	37.29
May.....	46.35	50.92	51.12	46.88	50.31	51.16	47 33	48.82	49.67	47.40	47.53	48 22	46.92	46.88	47.16	44.44	44.76	44.65	42.97	43.16	43.20
June............	58.10	63.02	63.08	58.46	62.89	62.86	58.45	59.50	60.44	58.86	58.59	59.89	58.67	58.64	58.79	54.15	54.19	54.14	51.29	51.41	51.44
July..	63.48	68.29	67.67	63.61	68.18	67.85	63.74	64.28	65.13	63.58	63.47	64.57	63.66	63.36	63.81	59.15	59.24	59.25	56.47	56.54	56.57
August	63.39	68.06	67.87	63.42	69.56	67.67	64.29	65.35	66.04	64.21	64.42	65.34	64.45	64.30	64.62	61.89	61.96	61.85	59.93	60.00	59 99
September	55.84	59.79	59.51	56.17	59.91	59.59	57.54	58.26	58.81	57.78	57.65	58.38	58 37	58.09	58.27	58.14	58.25	58.18	57.99	57.65	57.61
October..	44.61	46.64	46.85	44.60	46.56	46.82	46 87	46.82	47.29	46.80	46.62	46.34	47.97	47.83	47.85	50.82	50.80	50.76	51.93	51.88	51.87
Mean............	52.83	57.05	56.99	53.08	56.94	56.87	54.24	54.63	55.49	53.90	53.89	54.70	54.17	54.02	54.27	52.33	52.44	52.39	51.12	51.13	51.14
Mean temperature for seven months,	o 55.62			o 55.63			o 54.79			o 54.16			o 54.15			o 52.39			o 51.13		

In order that comparisons may be made between soil temperatures at different depths and the air temperatures during the same months and in the same locality, the following tables are added:

THERMOMETER IN THE OPEN AIR.

(Locality the same as that of the soil thermometers.)

1889.

	7 A. M.	1 P. M.	7 P. M.	Mean.
	°	°	°	°
May,	52.95	68.30	59.47	60.24
June,	63.36	74.27	68.07	68.57
July,	65.12	75.75	70.86	70.58
August,	59.97	74.20	66.81	66.99
September,	54.39	70.86	61.55	62.27
October,	37.41	52.80	44.05	44.75
Mean,	55.53	69.36	61.80	62.23

1890.

	7 A. M.	1 P. M.	7 P. M.	Mean.
	°	°	°	°
April,	35.76	49.02	42.55	42.44
May,	49.16	60.60	53.58	54.45
June,	57.95	67.64	62.76	62.78
July,	67.10	76.19	71.85	71.71
August,	61.50	73.78	68.84	68.04
September,	52.04	66.16	58.52	58.91
October,	37.70	53.19	45.63	45.51
Mean,	51.60	63.80	57 68	57.69

1891.

	7 A. M.	1 P. M.	7 P. M.	Mean.
	°	°	°	°
April,	36.33	48.26	43.64	42.74
May,	47.07	61.75	53.30	54.04
June,	58.28	72.42	65.38	65.36
July,	64.08	76.05	68.81	69.65
August,	62.07	74.94	67.47	68.16
September,	56.13	69.72	61.80	62.55
October,	38.11	54.02	45.56	45.90
Mean,	51.72	65.31	57.99	57.34

1892.

	7 A. M.	1 P. M.	7 P. M.	Mean.
	°	°	°	°
April,	37.29	51.93	45.10	44.77
May,	47.00	58.95	54.19	53.38
June,	58.74	70.65	67.29	65.56
July,	65.58	78.54	71.92	72.11
August,	61.16	74.15	67.46	67.50
September,	53.33	68.19	56.52	59.68
October,	40.98	51.65	45.13	45.94
Mean,	52.05	64.87	57.38	58.43

TABLES SHOWING CHANGES OF TEMPERATURE IN THE SOIL FOR INCREASED DEPTHS.

1889.

Depth of Thermometer.	Mean temperature for 6 mos., May to Oct. inclusive.	Difference in mean temperatures.	Changes in temperature for one inch.
	°	°	°
1 inch	60.50	+0.27	+0.13
3 inches	60.77	—1.14	—0.38
6 inches	59.63	—0.85	—0.28
9 inches	58.78	—0.52	—0.17
12 inches	58.26	—1.86	—0.15
24 inches	56.40	—1.61	—0.13
36 inches	54.79		

1890.

Depth of Thermometer.	Mean temperature for 7 mos., April to Oct. inclusive.	Difference in mean temperatures.	Changes in temperature for one inch.
	°	°	°
1 inch	54.63	+0.29	+0.14
3 inches	54.92	—0.96	—0.32
6 inches	53.96	—0.70	—0.23
9 inches	53.26	+0.05	+0.02
12 incnes	53.31	—1.35	—0.11
24 inches	51.96	—1.19	—0.10
36 inches	50.77		

1891.

Depth of Thermometer.	Mean temperature for 7 mos., April to Oct. inclusive.	Difference in mean temperatures.	Changes in temperature for one inch.
	°	°	°
1 inch..............	56.65	+0.24	+0.12
3 inches............	56.89	—1.33	—0.44
6 inches.	55.56	—0.82	—0.27
9 inches............	54.74	—0.22	—0.07
12 inches...........	54.52	—2.03	—0.17
24 inches...........	52.49	—1.13	—0.09
36 inches...........	51.36		

1892.

Depth of Thermometer.	Mean temperature for 7 mos., April to Oct. inclusive.	Difference in mean temperatures.	Changes in temperature for one inch.
	°	°	°
1 inch..............	55.62	+0.01	+0.003
3 inches............	55.63	—0.84	—0.28
6 inches............	54.79	—0.63	—0.21
9 inches............	54.16	—0.01	—0.003
12 inches...........	54.15	—1.76	—0.14
24 inches...........	52.39	—1.26	—0.10
36 inches...........	51.13		

An examination of the tables shows that the soil responds readily to the daily heat of the sun to the depth of three inches, less readily to the depth of six inches, in a moderate degree only to the depth of nine inches, and very slightly below twelve inches. To the depth of three inches the range between the morning and the midday observations has been as high as fifteen degrees. The mean daily range at the depth of 1 inch during the period of observations was 5°.22; at the depth of three inches, 4°.54; at the depth 6 inches, 1°.81; at the depth of 9 inches, 1°.02, and 12 inches very slight.

At the depth of 3 inches, the average temperature of the soil was somewhat higher than at the depth of 1 inch. The surface soil averaged about five degrees warmer than the soil 36 inches below the surface.

The rate of reduction of temperature with depth below the layer three inches from the surface is shown in a general way in the foregoing tables.

This rate is probably in accordance with a simple law which can be expressed by a mathematical formula, variable, undoubtedly, for different soils. However, on examining the "changes in temperature for one inch" in the foregoing tables, it will be noticed that the rate has been clearly vitiated since 1889 by the record of the nine inch thermometer.

The anomalous action of this instrument is accounted for by the fact, that at the end of the year 1889, the nine inch thermometer first used was broken and a new one was substituted. The contact of the latter with the soil was not the same as that of the former, nor has it been the same as that of the other instruments which have not been disturbed in the four years.

This accident, although vitiating the results of the present investigation, is not without its value, since it clearly indicates the need of maintaining uniform conditions in carrying on a work of the nature and delicacy of that for which soil thermometers are employed.

Comparing soil temperatures with air temperatures during the four seasons, the following mean results appear: At the depth of 1 inch, the temperature of the soil was lower than at that of the air by 2°.32; at the depth of 3 inches, by 2°.12; 6 inches, by 3°.22; 9 inches, by 3°.94; 12 inches, by 4°.12; 24 inches, by 5°.86, and at the depth of 36 inches, by 7°.16.

TERRESTRIAL RADIATION.

The heat radiated from the surface of the earth during the night reduces its temperature several degrees below that of the surrounding atmosphere. The amount of this radiation or the consequent reduction of temperature is approximately shown by comparing the readings of a terrestrial radiation thermometer with those of a minimum thermometer. In obtaining data for the comparison given below, the minimum thermometer was four feet above the ground and the terrestrial radiation thermometer was within six inches of its surface. The results are based on monthly averages from May to October inclusive, 1889, from April to October inclusive, 1890, 1891 and 1892.

TABLE SHOWING LOSS OF HEAT BY TERRESTRIAL RADIATION.

1889.

	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
	°	°	°	°	°	°	°
Mean of minimum temperatures......	46.63	53.25	55.08	53.65	49.07	33.91	48.50
Mean of Temp. from Ter. Rad. Ther..	38.48	49.20	50.59	47.66	44.60	28.48	43.17
Loss of heat by radiation...........	8.15	4.05	4.49	5.39	4.74	5.43	5.33

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1890.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
	°	°	°	°	°	°	°	°
Mean of minimum temperatures......	29.17	42.52	48.71	53.61	53.52	45.32	36.05	44.13
Mean of Temp. from Ter. Rad. Ther..	19.95	37.10	42.10	44.55	46.25	38.40	27.14	36.50
Loss of heat by radiation.....	8.22	5.42	6.61	9.06	7.27	6.92	9.91	7.63

1891.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
	°	°	°	°	°	°	°	°
Mean of minimum temperatures......	30.22	37.67	49.18	53.15	54.07	49.23	34.95	44.07
Mean of Temp. from Ter. Rad. Ther..	24.45	29.09	40.87	43.94	47.40	42.22	25.60	36.23
Loss of heat by radiation...........	5.77	8.58	8.31	9.21	6.67	7.01	9.35	7.84

1892.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
	°	°	°	°	°	°	°	°
Mean of minimum temperatures......	30.32	39.08	50.73	54.65	55.77	45.69	34.47	44.39
Mean of Temp. from Ter. Rad. Ther..	22.29	30.64	41.89	45.05	46.38	37.45	28.02	35.96
Loss of heat by radiation............	8.03	8.44	8.84	9.60	9.39	8.24	6.45	8.43

On cloudy nights the difference in the reading of the two thermometers is small, and on exceptionally clear (dry) nights it is a maximum. The greatest range observed was 19.5° Occasionally, the reading of the radiation thermometer is higher than that of the minimum thermometer, showing that the moist air at such times, resting upon the surface of the ground, serves as a warm blanket, and that the amount of heat then absorbed is greater than that radiated. The table above shows that the mean radiation for the four seasons was 7.31°.

SOLAR RADIATION.

The temperature of the atmosphere does not indicate the intensity of the sun's heat, as only a small percentage is absorbed as the rays are transmitted through the air. The maximum thermometer in the shade, therefore, does not give the intensity of solar radiation; neither does exposure of an ordinary thermometer to the direct rays of the sun, in consequence of the cooling effects of draughts of air. In order to avoid the effects of currents of air, the *vacuum solar radiation thermometer* has been devised. "This consists of a blackened bulb radiation thermometer inclosed in a glass tube and globe, from which all air is exhausted. Thus protected from the loss of heat which would ensue if the bulb were exposed, its indications are from 20° to 30° higher than when placed side by side with a similar instrument with the bulb exposed to the passing air." By the use of this instrument the amounts of solar radiation at different places and in different seasons at the same place are rendered comparable. The relations of solar-intensity, as distinct from temperature of the air to the growth and maturity of crops, are worthy of careful investigation. High solar intensity maintained through the latter part of the growing season has an important bearing upon the complete ripening of vegetables and fruits and likewise upon their keeping qualities. From the wide range of observations undertaken by Experiment Stations with radiation thermometers, important deductions may reasonably be expected. I subjoin tables of results from the maximum thermometer and the thermometer for solar radiation, expressed in monthly averages.

1889.

	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
	o	o	o	o	o	o	o
Mean of readings, Sun Ther.......	133.02	134.22	139.55	137.56	122.79	105.86	128.83
Mean of maximum temperatures.....	67.85	73.45	75.30	73.72	71.23	52.78	69.05
Excess of solar intensity.............	65.17	60.77	64.25	63.84	51.56	53.08	59.78

1890.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean
	o	o	o	o	o	o	o	o
Mean of readings, Sun Ther..	119.15	119.45	128.81	139.37	138.25	114.94	112.52	124.65
Mean of maximum Temp.....	49.37	61.16	68.01	76.53	74.67	62.32	55.61	64.38
Excess of solar intensity......	69.82	58.29	60.80	62.84	63.58	49.62	56.92	60.27

1891.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
	o	o	o	o	o	o	o	o
Mean of readings, Sun Ther..	106.78	119.19	129.44	140.35	129.55	121.65	99.55	120.93
Mean of maximum Temp.....	50.65	62.48	72.17	76.68	75.39	69.84	54.18	65.91
Excess of solar intensity......	56.13	56.71	57.27	63.67	54.16	51.81	45.37	55.02

1892.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
	o	o	o	o	o	o	o	o
Mean of readings, Sun Ther..	113.32	112.47	127.11	139.50	128.25	123.82	97.62	120.30
Mean of maximum Temp.....	53.93	62.22	72.87	82.28	75.07	68.74	53.16	66.90
Excess of solar intensity......	59.39	50.25	54.24	57.22	53.18	55.08	44.46	53.40

From the above records it appears that the average excess of solar intensity above that given by the maximum thermometer for the growing periods of 1889, 1890, 1891 and 1892 was 57.12°.

The season of greatest excess in this regard was that of 1890, a season noted for the perfect maturity of fruits and vegetables.

AMOUNT OF SUNSHINE.

The amount of sunshine as an essential factor in crop production is worthy of observation and record. Observations were commenced May 1, 1890, and the table below furnishes the summary for the six months following and for seven months, April to November, 1891, and for seven months, April to November, 1892.

BRIGHT SUNSHINE IN HOURS.

1890.

	May.	June	July.	Aug.	Sept.	Oct.	Mean.
Sunshine,	180	186	216	193	126	103	173
Hours per day, mean,	5.8	6.2	7.0	2.6	4.2	3.3	5.6

1891.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
Sunshine,	174	207	217	259	225	234	154	209
Hours per day, mean,	5.8	6.7	7.2	8.4	7.3	7.8	5.0	6.9

1892.

	April.	May.	June.	July.	Aug.	Sept.	Oct.	Mean.
Sunshine,	228	123	198	294	178	259	149	208
Hours per day, mean,	7.6	4.0	6.6	9.5	5.6	8.6	4.8	6.7

During the period covered by the above table, the average hours of bright sunshine per day were 6.4 or 46 per cent. of the possible amount.

WIND AND RAIN.

The velocity of the wind has been determined by a Robinson's Anemometer, with electrical recording apparatus, attached to the Experiment Station building, and the amount of rain by means of a guage, signal service pattern, located in the same plat as the soil thermometers.

1889.

	WIND.		RAIN.
	Mean distance travelled per day. Miles.	Velocity per hour. Miles.	Amount. Inches.
April,	253.93	10.58	1.36
May,	189.83	7.91	1.61
June,	171.12	7.13	4.86
July,	200.33	8.34	3.27
August,	139.35	5.81	1.69
September	198.06	8.25	2.10
October,	194.31	8.09	3.96
Mean,	192.42	8.02	Total, 18.85

1890.

	WIND.		RAIN.
	Mean distance travelled per day. Miles.	Velocity per hour. Miles.	Amount. Inches.
April,	241.83	10.07	1.98
May,	235.14	9.79	10.13
June,	230.40	9.60	3.78
July,	166.28	6.95	3.84
August,	187.03	7.65	5.39
September,	155.50	6.45	4.21
October,	189.01	7.85	3.19
Mean,	200.74	8.34	Total, 32.52

1891.

	WIND.		RAIN.
	Mean distance travelled per day. Miles.	Velocity per hour. Miles.	Amount. Inches.
April,	210.55	8.77	3.18
May,	206.25	8.59	2.76
June,	182.71	7.61	3.13
July,	185.44	7.73	3.36
August,	169.58	7.07	4.38
September,	162.07	6.75	3.50
October,	191.92	8.00	2.81
Mean,	186.93	7.79	23.07

1892.

	WIND.		RAIN.
	Mean distance travelled per day. Miles.	Velocity per hour. Miles.	Amount. Inches.
April,	244.99	10.21	1.09
May,	262.23	10.93	1.99
June,	197.87	8.24	5.66
July,	199.50	8.31	1.88
August,	168.36	7.02	6.11
September,	185.28	7.72	3.43
October,	199.13	8.26	1.46
Mean,	208.19	8.67	21.62

For the full year 1890, the mean daily velocity of the wind was 211.16 miles and the mean hourly velocity, 8.90 miles; for the full year 1891, the corresponding velocities were respectively 214.82 miles and 8.95 miles; and for the full year 1892, 217.33 miles and 9.05 miles.

The rain-fall in May, 1890, amounting to 10.13 inches was larger than in any other month in twenty-four years.

CONCLUSION.

The foregoing summarized report, although embodying all the data obtained by four years' observations, conveys but an imperfect idea of the daily requirments and nature of the work in progress.

By way of presenting its varied character more fully, as in former years, I append the complete records for one month, selecting for the current report the month of October 1892.

HYGROMETER NO. 1.—IN OPEN FIELD.

OCTOBER, 1892.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.
	°	°	°	°	°	°	°	°	°	°	°	°
1.	52.2	45.2	37	57	50.5	44.5	37	61	44.2	39.4	32	65
2.	41.8	37.0	29	63	49.5	41.2	29	46	43.0	38.6	32	67
3.	29.8	29.0	26	91	46.5	41.0	34	62	43.0	42.5	42	96
4.	46.5	46.2	45	98	51.0	48.7	46	85	48.8	48.1	47	95
5.	34.8	34.8	34.8	100	49.8	44.4	38	65	45.2	42.0	39	77
6.	41.5	38.8	36	79	49.0	42.9	36	59	44.2	40.2	35	70
7.	44.2	41.5	38	80	59.0	52.8	48	66	50.0	48.0	46	87
8.	44.8	44.0	42	90	63.4	58.7	51	55	58.2	54.8	52	81
9.	50.1	50.0	50	99	45.8	44.0	42	87	42.4	40.8	39	87
10.	30.3	30.0	28	97	50.1	42.2	31	50	48.0	41.5	33	56
11.	39.7	38.0	36	86	51.0	42.5	31	47	38.8	35.0	29	69
12.	30.0	28.8	27	87	49.0	42.4	34	56	44.2	38.8	30	60
13.	28.0	28.0	28	100	44.8	43.8	42	92	49.4	48.3	47	92
14.	55.0	52.0	50	82	65.7	58.0	51	55	57.0	51.3	47	68
15.	45.0	43.0	41	85	60.1	51.0	43	52	49.8	45.7	42	73
16.	52.2	51.2	50	94	53.2	53.0	52	99	53.4	52.9	52	97
17.	40.0	37.0	33	76	48.4	41.2	33	53	37.2	35.6	33	86
18.	25.6	25.2	24	95	52.8	44.5	34	50	41.1	39.6	37	88
19.	48.7	48.2	48	97	52.0	51.4	51	96	51.2	50.6	50	96
20.	42.4	41.1	40	90	52.8	44.0	33	48	43.0	38.5	32	66
21.	37.8	34.3	29	70	50.7	40.0	25	35	41.7	36.5	29	60
22.	44.9	39.0	30	58	55.2	43.8	28	37	47.7	41.5	38	59
23.	45.1	42.2	39	79	49.9	47.5	45	84	46.6	43.0	40	75
24.	40.0	37.0	33	76	46.1	40.5	33	60	43.8	39.1	33	65
25.	37.7	36.2	34	87	50.9	44.5	37	60	47.9	42.6	36	64
26.	38.8	38.0	37	94	46.7	43.0	40	74	44.7	43.0	42	87
27.	40.3	40.2	40	99	44.9	43.1	43	94	43.6	41.0	38	80
28.	37.3	36.0	35	89	49.5	43.6	37	62	43.7	40.0	36	72
29.	30.0	29.3	28	91	43.8	39.9	35	71	41.2	40.0	39	90
30.	36.2	35.3	34	92	48.0	40.9	32	52	42.1	38.0	33	68
31.	31.0	30.0	28	90	43.2	38.9	32	68	40.3	36.8	31	72
Means.				86				64				76
Mean for month.								75				

HYGROMETER NO. 2.—IN OPEN FIELD.

OCTOBER, 1892.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.
	°	°	°	°	°	°	°	°	°	°	°	°
1.	53.2	45.0	35	51	51.0	42.0	30	45	43.2	35.3	21	42
2.	43.1	37.2	28	56	48.8	40.2	28	44	39 5	35.7	30	70
3.	32.5	32.0	30	95	47.3	44.3	41	79	43.0	42.2	41	94
4.	46.9	46.5	46	97	52.1	50.3	49	89	47.8	47.2	47	95
5.	35.7	35.7	35.7	100	50.5	45.0	38	64	45.9	41.7	37	70
6.	42.2	39.1	35	76	49.5	43.5	37	61	44.2	40.3	35	71
7.	45.2	42.3	39	79	60.8	53.3	47	61	50.2	48.1	46	86
8.	48.0	47.1	46	94	68.0	59.1	53	59	52.5	49.7	47	85
9.	50 0	50.0	50	100	46.2	44.2	42	85	39.8	39.0	37	94
10.	30.5	30.3	29	98	50.2	42.5	32	51	47.1	41.0	33	59
11.	40.0	38.5	36	88	52.3	44.5	34	52	38.1	34.8	29	72
12.	33.0	32.0	30	92	49.0	43.0	36	60	41.8	38.0	33	71
13.	28.9	28.8	28	99	45.8	44.3	43	89	49.2	48.2	47	93
14.	55.6	51.8	49	78	67.8	57.9	51	55	56.5	51.8	49	73
15.	47.5	45.8	44	88	64.0	53.8	46	50	50.2	46.0	42	72
16.	52.7	51.2	50	91	53.8	53.0	51	95	54.0	53.2	52	95
17.	40.0	37.0	33	76	49.1	42.5	34	56	35.3	33.9	31	87
18.	27.7	27.0	25	92	54.7	41.6	23	28	40.0	39.2	38	94
19.	49.0	48.5	48	97	52.1	51.5	51	96	51.2	50.4	49	95
20.	43.6	41.2	38	82	52.4	47.7	43	71	41.8	37.3	31	65
21.	39.0	35.2	29	69	49.5	40.7	27	43	40.1	35.8	28	65
22.	44.8	39.8	33	64	55.8	44.6	31	38	47.2	40.8	31	56
23.	45.3	42.3	39	78	49.8	46.7	44	79	45.4	42.9	40	82
24.	39.8	37.0	33	78	46.9	40.8	33	58	43.6	39.0	33	66
25.	38.8	37.3	35	88	51.8	44.8	36	56	47.8	42.1	36	62
26.	39.0	38.5	38	96	47.2	43.4	39	74	44.3	42.8	41	88
27.	41.7	41.3	41	97	46.1	44.	43	87	44.0	41.2	37	79
28.	35.7	34.0	32	84	52.5	46.1	39	61	39.9	37.8	35	83
29.	32.3	31.0	28	87	44.0	40.0	35	70	42.2	40.8	39	89
30.	36.3	35.5	34	93	46.8	41.6	35	64	41.8	38.0	33	71
31.	32.3	31.5	29	92	43.5	38.0	29	58	41.0	37.0	31	68
Means.				83				64				77
Mean for month.								75				

HYGROMETER NO. 3.—IN FOREST.

OCTOBER, 1892.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.
	°	°	°	°	°	°	°	°	°	°	°	°
1.	52.2	47.4	42	70	50.5	44.8	38	63	43.2	38.3	31	62
2.	40.1	36.9	33	74	47.7	42.8	37	67	44.0	40.8	37	76
3.	30.2	29.3	27	90	46.2	43.0	40	77	43.4	42.9	42	96
4.	46.8	46.0	44	94	50.0	49.1	48	94	48.7	48.0	48	95
5.	38.5	38.5	38.5	100	48.0	45.7	43	84	46.5	44.5	42	85
6.	41.1	39.2	36	85	47.8	44.3	41	76	45 0	42.4	40	81
7.	45.2	42.8	40	83	57.0	53.6	51	81	50.3	48.8	49	97
8.	46.5	44.6	42	86	62.0	58.5	56	81	58.0	55.0	53	83
9.	50.2	50.2	50.2	100	46.3	45.3	44	93	43.8	42.8	42	92
10.	32.0	31.9	30	99	46.8	43.0	39	74	47.8	44.0	40	74
11.	40.5	37.8	35	78	48.0	44.4	41	75	40.0	37.8	35	82
12.	30.6	29.5	28	89	48.1	44.9	42	78	46.0	43.0	40	79
13.	29.0	27.8	26	87	41.0	40.7	40	98	47.2	47.0	46	99
14.	51.8	51.5	51	98	65.2	60.5	58	66	56.8	53.8	52	83
15.	39.0	37.8	37	90	55.0	52.1	50	83	50.7	48.6	47	86
16.	50 9	50.5	50	98	52.4	52.2	51	99	52.2	52.0	51	99
17.	40.4	38.9	36	88	46.3	43.1	39	77	39.2	38.8	38	97
18.	27.3	27.0	25	96	47.4	44.8	42	81	41.7	40.5	40	90
19.	48.8	48.2	48	96	51.8	50.9	50	95	51.2	50.8	50	98
20.	41.7	40.2	39	88	53.4	47.0	39	62	41.9	39.4	36	81
21.	36.8	35.4	33	88	48.0	44.5	41	76	41.0	37.7	33	74
22.	42.6	40.4	39	83	49.8	44.7	40	67	48.6	43.0	37	62
23.	41.7	40.6	40	91	49.0	46.0	43	80	46.4	43.8	41	81
24.	39.5	37.4	34	82	45.8	41.9	37	73	45.0	41.2	36	73
25.	37.0	35.8	35	89	49.8	45.1	41	69	48.8	44.0	38	68
26.	39.0	37.8	37	90	46.0	44.0	42	85	44.7	43.1	42	88
27.	41.0	40.0	39	92	44.8	44.0	42	94	46.0	45.0	44	93
28.	38.0	36.5	34	87	45.0	42.3	40	80	42.2	40.7	39	88
29.	30.8	29.8	28	90	42.0	40.8	40	90	40.6	39.8	39	94
30.	35.7	35.7	35.7	100	45.0	41.3	37	75	41.5	38.4	35	76
31.	31.3	30.0	26	86	41.3	38.0	33	74	41.0	38.8	38	91
Means.				90				80				85
Mean for month.								85				

HYGROMETER NO. 4.—IN FOREST.

OCTOBER, 1892.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.
	°	°	°	°	°	°	°	°	°	°	°	°
1.	52.0	46.3	41	65	50.6	44.2	37	60	42.9	38.0	31	63
2.	40.8	37.0	31	70	47.5	41.0	31	55	43.2	39.8	35	75
3.	30.3	29.5	27	91	46.2	42.9	39	77	43.1	42.6	42	96
4.	46.8	46.5	46	98	49.6	49.0	48	96	49.2	48.8	48	98
5.	36.3	36.3	36.3	100	47.8	45.7	44	85	46.0	44.0	42	85
6.	41.0	39.1	36	85	47.3	43.8	40	76	45.0	43.5	42	89
7.	43.8	42.2	41	87	57.0	53.0	50	77	50.5	48.1	45	84
8.	45.3	44.2	43	91	62.4	59.3	57	83	56.0	54.7	54	92
9.	50.4	50.4	50.4	100	45.4	45.0	44	97	42.5	42.0	41	96
10.	31.7	31.6	30	99	46.4	41.9	36	68	47.2	43.5	40	74
11.	40.0	37.0	33	76	47.4	44.2	41	78	39.5	38.8	38	94
12.	29.9	29.1	27	91	47.5	43.9	41	75	44.0	41.4	38	80
13.	30.0	28.8	27	87	40.5	40.1	39	97	48.0	47.6	47	97
14.	49.5	49.3	49	99	64.0	58.3	55	71	53.4	51.0	48	85
15.	38.8	38.0	37	94	55.8	51.9	49	78	49.2	46.8	44	84
16.	52.0	50.3	49	89	52.6	52.3	52	99	52.4	52.2	51	99
17.	40.1	38.8	35	85	46.4	42.5	37	73	37.5	36.8	36	94
18.	27.3	27.1	25	98	47.5	43.6	40	74	41.4	40.3	39	91
19.	48.5	48.0	47	96	52.0	51.2	50	95	51.2	51.0	50	99
20.	40.2	40.0	39	98	49.6	45.3	41	72	41.5	39.5	36	84
21.	37.2	35.3	33	88	46.4	42.1	36	70	40.6	37.8	34	78
22.	42.8	40.5	38	83	53.1	44.9	36	51	49.0	44.1	38	68
23.	42.5	40.7	39	86	49.3	48.3	47	93	45.6	43.8	42	87
24.	39.4	37.7	35	86	45.7	41.6	37	71	45.0	41.5	37	75
25.	35.0	34.5	33	95	50.0	44.9	40	67	47.4	44.2	41	78
26.	38.8	37.8	36	92	45.5	43.8	43	87	44.3	43.2	42	91
27.	40.6	40.0	40	95	44.5	43.8	43	94	43.3	43.0	42	98
28.	37.0	36.5	36	96	45.8	43.3	41	82	41.0	39.9	39	91
29.	30.7	30.3	29	96	41.8	40.0	38	86	40.8	40.1	40	94
30.	35.7	35.7	35.7	100	44.3	41.0	36	76	41.2	38.8	35	91
31.	31.3	30.5	28	92	41.0	38.0	34	76	40.7	38.0	35	78
Means.				91				79				86
Mean for month.								85				

SOIL THERMOMETERS.—OCTOBER, 1892.

Day.	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M	7 P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1	53.7	53.0	50.5	54.0	53.5	51.2	54.6	54.0	53.3	54.0	53.8	53.5	54.5	54.5	54.3	55.6	55.6	55.5	56.2	56.0	55.8
2	46.8	48.0	48.0	46.4	48.0	48.0	50.5	49.8	49.8	50.8	50.0	50.0	52.7	51.9	51.6	55.4	55.3	55.0	55.7	55.7	55.5
3	44.0	47.5	47.5	43.5	47.7	47.0	47.9	48.1	48.5	48.4	48.0	48.5	50.5	49.9	50.0	54.6	54.5	54.2	55.4	55.4	55.3
4	48.0	49.4	49.0	48.3	49.4	50.0	49.0	49.5	50.1	48.9	49.0	49.5	50.0	50.2	50.4	53.8	53.7	53.6	54.9	54.9	54.8
5	46.5	48.4	48.5	47.6	48.4	48.5	49.4	49.0	49.3	49.2	48.7	49.0	50.5	50.1	50.0	53.4	53.3	53.2	54.5	54.4	54.4
6	45.8	47.0	47.0	46.4	47.6	47.5	48.4	48.2	48.3	48.2	48.0	48.0	49.8	49.4	49.4	53.0	53.0	52.8	54.0	54.0	53.9
7	45.2	49.4	49.6	45.5	49.0	49.6	47.2	47.9	48.2	47.1	47.4	47.5	48.8	48.6	49.0	52.5	52.5	52.3	53.8	53.7	53.5
8	47.0	53.0	53.3	48.0	52.0	53.0	49.0	50.0	51.4	48.8	49.2	50.5	49.6	49.8	50.5	52.2	52.3	52.2	53.4	53.5	53.4
9	51.5	50.5	50.0	51.5	50.6	50.2	51.6	51.4	51.0	50.3	51.1	51.0	51.5	51.5	51.5	52.4	52.4	52.4	53.3	53.2	53.0
10	44.8	44.9	48.2	45.5	46.5	48.2	48.6	48.0	48.5	48.7	48.6	48.4	50.2	49.4	49.4	52.4	52.5	52.3	53.0	52.5	53.0
11	45.9	45.9	46.2	46.1	46.7	46.4	47.8	47.8	48.0	47.7	48.0	48.0	49.0	49.4	49.8	50.0	51.7	51.8	52.8	52.6	52.8
12	42.2	47.0	45.8	39.4	47.0	45.5	46.0	47.6	46.4	46.2	47.5	46.2	48.0	48.7	47.4	51.5	51.9	51.5	52.5	52.8	52.5
13	40.7	42.6	45.0	41.3	42.8	44.9	44.3	44.8	45.4	45.0	44.8	45.1	45.8	46.2	46.3	51.0	50.8	50.8	52.3	52.2	52.3
14	45.0	49.0	50.0	45.0	48.5	49.7	46.0	46.9	48.7	45.5	46.1	47.8	46.5	46.9	47.7	50.4	50.4	50.4	52.0	51.8	52.0
15	45.0	49.5	49.6	45.0	47.4	49.0	47.5	47.5	48.8	47.5	47.3	48.2	48.4	48.0	48.4	50.4	50.5	50.4	51.5	52.1	51.7
16	48.4	49.5	50.3	48.4	49.5	50.0	48.5	49.2	49.4	48.3	48.5	48.9	49.0	49.0	49.3	50.5	50.5	50.7	51.5	51.5	51.5
17	47.4	47.5	47.0	47.5	47.4	46.9	49.4	48.5	48.6	49.2	48.5	48.5	49.7	49.4	49.7	50.5	50.6	50.8	51.5	51.3	51.5
18	42.2	46.0	46.1	42.7	45.1	46.1	46.2	45.6	46.8	46.5	45.7	46.6	48.0	47.4	47.5	50.6	50.6	50.5	51.5	51.5	51.5
19	46.1	48.0	48.8	46.3	47.9	48.6	46.8	47.5	48.2	46.6	47.0	47.5	47.5	49.6	48.1	50.2	50.1	50.3	51.3	51.3	51.4
20	45.4	47.0	46.0	45.7	45.9	45.9	47.3	46.9	47.3	47.1	46.7	47.1	48.0	47.8	47.8	50.0	50.0	49.9	51.0	51.0	51.0
21	42.2	44.2	43.5	41.4	44.2	43.8	45.4	45.1	45.4	45.4	44.8	45.2	46.9	46.2	46.1	50.1	49.8	49.6	51.0	50.7	50.7
22	42.4	44.8	45.2	42.7	44.4	45.0	44.7	44.5	45.3	44.4	44.3	45.1	45.8	45.6	46.0	49.7	49.5	49.4	50.7	50.7	50.7
23	41.1	44.0	44.3	41.5	43.0	44.3	44.0	44.0	44.7	44.0	43.7	44.2	45.5	45.0	45.3	49.2	49.0	48.9	50.1	50.4	50.4
24	42.4	43.4	44.0	42.7	43.5	44.0	44.3	43.1	44.5	44.0	43.8	44.2	45.4	45.0	45.0	48.8	48.6	48.5	50.2	50.0	50.0
25	42.0	44.0	45.0	42.0	44.2	44.0	44.0	44.0	44.8	44.0	43.6	44.2	45.0	44.9	45.0	48.5	48.5	48.4	49.8	49.8	49.8
26	42.7	44.6	45.0	42.0	44.5	45.0	44.5	44.5	45.0	44.3	44.4	44.5	45.2	45.1	45.4	48.3	48.3	48.3	49.7	49.6	49.8
27	44.0	45.0	46.0	43.0	46.0	46.3	45.0	45.2	44.6	44.8	44.6	45.0	45.7	45.5	45.6	48.7	48.1	48.2	49.5	49.5	49.5
28	43.5	45.5	45.5	42.5	45.7	45.0	45.0	44.9	45.8	45.0	44.5	45.2	45.7	45.5	45.7	48.2	48.2	48.2	49.5	49.3	49.4
29	41.0	44.0	43.6	40.5	43.4	43.5	44.3	43.6	44.2	44.2	43.5	44.0	45.5	45.0	45.5	48.0	47.0	48.2	49.2	49.2	49.3
30	40.4	42.5	42.5	40.5	42.5	42.5	43.0	43.0	43.2	44.2	43.0	43.2	44.6	44.1	44.1	47.9	47.9	47.9	49.0	49.0	49.0
31	39.5	40.8	41.5	39.8	41.0	41.8	42.4	41.9	42.4	42.4	41.6	42.0	43.7	43.2	43.2	47.5	47.5	47.3	48.9	48.7	48.7
Means	44.61	46.64	46.85	44.60	46.56	46.82	46.87	46.82	47.20	46.80	46.62	46.34	47.97	47.88	47.85	50.82	50.80	50.76	51.96	51.88	51.87

October, 1892.

Maximum and Minimum Thermometers.			Terrestrial Radiation and Sun Thermometer.		Sunshine.	Precipitation.			Wind. Anemometer observed at 1 P.M. daily.		
Day.	Maximum.	Minimum.	Terrestrial Radiation.	Sun Thermometer.	Hours of Sunshine.	Time of beginning.	Time of ending.	Amount of rain in inches.	Reading.	Number of miles in last twenty-four hours.	Average rate per hour.
	°	°	°	°							
1	54.1	43.2	33.6	120.0	8.5				141.2	436.4	18.18
2	50.5	33.0	28.6	110.2	8				550.8	409.6	17.07
3	49.5	24.8	17.5	96.2	2	2 P.M.			638.3	87.5	3.65
4	52.5	42.0	39.0	76.1	0		6 P.M.	.46	757.4	119.1	4.96
5	51.2	33.7	27.7	111.5	2				888.0	130.6	5.44
6	51.4	35.4	30.4	100.0	2				223.2	325.2	13.55
7	61.2	35.7	30.0	110.5	0				509.8	286.6	11.94
8	68.5	42.5	37.0	117.5	8	9 P.M.			641.3	131.5	5.48
9	58.2	39.8	38.2	64.5	0.5		10.30 A.M.	.30	791.2	149.9	6.25
10	54.8	28.4	22.6	111.1	10				913.5	122.3	5.10
11	50.1	36.8	26.0	117.9	9.5				71.8	148.3	6.18
12	52.6	25.8	18.0	108.7	11				283.5	211.7	8.28
13	50.0	23.5	16.5	68.2	0.5				333.5	50.0	2.08
14	67.2	45.0	37.3	113.0	7				508.3	174.8	7.28
15	60.2	31.3	23.8	112.8	10				678.0	169.7	7.07
16	54.1	44.7	39.8	56.0	0				876.7	198.7	8.28
17	50.1	36.6	25.5	103.3	8.5				151.8	265.1	10.05
18	54.9	22.7	17.2	117.4	6				246.5	94.7	3.95
19	53.0	38.1	32.2	55.0	0	10 A.M.	4 P.M.	.07	387.1	140.6	5.86
20	54.0	38.9	30.0	108.5	8				590.5	203.4	8.48
21	51.1	33.3	23.5	102.0	7.5				895.8	305.3	12.68
22	56.2	33.0	31.8	102.6	10.5				294.5	388.7	16.20
23	51.2	31.3	22.2	105.0	2.5	10.40 A.M.	1.30 P.M.	.06	455.2	160.7	6.70
24	49.0	37.8	32.6	96.4	3				758.3	303.1	12.63
25	53.1	35.3	25.8	102.2	4				88.9	270.6	11.28
26	47.2	34.0	25.8	60.0	0				139.8	100.9	4.20
27	50.8	38.5	33.0	100.0	0.5				218.5	78.7	3.28
28	52.6	35.7	28.6	106.7	7				281.0	62.5	2.60
29	46.8	27.3	22.0	101.8	3	2 P.M.	Night	.57	342.5	61.5	2.56
30	48.6	32.5	29.5	103.8	7				661.8	319.3	13.30
31	45.4	28.8	22.8	67.4	2.5				927.8	266.0	11.08
				Total	149		Total	146	Total	6178.0	
Means	53.16	34.47	28.02	97.62	4.8					199.18	8.26

MAINE AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 4.

SECOND SERIES.

TESTING CREAM AND MILK FAT TEST AND LACTOMETER.

J. M. Bartlett.

Notes on Testing Cream.

As many creameries are adopting the fat test as a measure by which to pay for their cream, it is of the utmost importance that the samples for the test should be properly taken. Cream from a herd of several cows raised at the proper temperature and skimmed in a proper manner will not vary much in butter fat from day to day, but all patrons are not sufficiently careful in skimming and handling their cream so that it is subject to no small amount of variation, causing the creamery man considerable trouble.

The skimming should never be done by dipping the cream from the top of the milk, as this method always involves a loss of both cream and skimmed milk. The loss of cream is from its being mixed with the milk by the dipping and the loss of milk to the farmer is by a large amount being taken up with the cream in an effort to secure all the cream. This milk is taken to the factory and is a total loss to the farmer. The skimming should be done as cleanly as possible and this is best accomplished by a faucet near the bottom of the can. The next best thing is a syphon by means of which the milk or cream can be drawn off separately.

The above mentioned difficulties to the creamery managers, however, can be wholly overcome by the composite sample, first recommended for milk by Prof. Patrick, of the Iowa Experiment Station. There are several ways of taking this sample. One is to provide the collector with a measuring can and a small can marked with the patron's name or number in which to put the sample. The cream is measured, then thoroughly mixed and a portion taken out, put in the sample can and sealed. The amount taken should be an aliquot part of the whole.

If need be the small can may be spaced or marked, as some dealers in dairy supplies have suggested, the same as the measuring can. Then as many spaces or inches of cream can be put in the sample can as there are in the measuring can. Such samples are taken every time a patron's cream is collected, sent to the factory, put in another can or jar marked with the patron's name and kept in an ice chest until the test is made. This constitutes the composite sample which, when tested at the end of one or two weeks as desired, will show accurately the per centage of fat in the patron's cream for that period. With this per-centage and the weight of cream furnished, the exact number of pounds of butter fat supplied by this patron can be calculated.

Another method of taking the sample is to bring the cream of each patron to the factory in a can by itself and then take the sample. This involves having a large number of cans for collecting and in some cases is not practical, but on the other hand the man that makes the test has an opportunity to see that the sample is properly taken.

In some cases it is desirable to defer testing for quite a time and the portion of cream reserved for the test becomes sour and curdled. When in this condition it is best brought into shape for measuring in the pipette by the method suggested by Mr. E. H. Farrington, Illinois Station, for handling sour milk, which is, to add to the sample a small amount of "Concentrated Lye" (caustic soda) in powder, about one-half teaspoonful to a pint of cream and heat to about 110° to 125° F, shake thoroughly and allow to cool, when it will be found in as good condition to measure as when fresh.

In regard to apportioning the proceeds, or paying by the test, we will simply repeat what was said in a previous bulletin, that we think it better not to calculate the fat to butter, but allow each patron such a share of the butter made for a given period as the amount of fat he furnished shows he is entitled to receive.

For instance, suppose that a creamery makes 10,000 pounds of butter in a week and receives from its patrons 8,200 pounds butter fat according to test. Mr. A. furnished 82 pounds of that butter fat; then he is entitled to one hundredth of 10,000 or 100 pounds of butter. Butter ordinarily contains from 79 to 87 per cent. butter fat; a correct average, therefore, would be about 83 per cent. for those parties who find it more convenient to calculate the fat over to butter.

In Bulletin No. 3, of this Station, two formsof cream bottles are described. The one designated as cream bottle No. 2, graduated to read to 25 per cent. fat, was at that time recommended for use in testing cream raised by the cold deep setting process in prefers ence to the bottle with a separable neck, which is shown by the accompanying cut and designated as test bottle No. 3. Since that time the writer has made many tests with bottle No. 3, and prefers it in many respects to any other form for the following reasons:

1st. The base is the portion most liable to break and is comparatively inexpensive.

2nd. A large number of the bases can be had at small cost; allowing samples to be measured out and put away to test at some more convenient time. Only one set of the more costly graduated necks are needed to carry on the work.

3rd. The fat can be measured more accurately as all the bottles are set in a tank of water heated to 110 to 120 Fah., and the per cent. of fat is read at a uniform temperature.

4th. Because cream very rich in fat can be tested.

Method of Working with This Bottle. Measure 18c. c. of cream into the base portion of the bottle in the manner given in the directions for measuring milk. Then measure in about 18c. c. of sulphuric acids spe. grav. 1.82–1.83, thoroughly mix the acid with the cream, place the bottle, without the neck, in the centrifugal machine and whirl five minutes at the rate of 800 to 900 revolutions per minute, then fill nearly full with hot water and whirl for two minutes more to bring the fat on top the water, remove from the machine without shaking, and connect the base with the graduated neck by means of a short rubber tube supplied for the purpose, and stand in a small tank filled with water heated to 110 to 120 F. The tank must be deep enough to allow the water to come up within an inch or two of the top of the neck. The fat is now raised into the neck by filling the bottle to the 33 or 34 mark with a hot mixture of acid and water, one part acid to two of water. In making this mixture the acid should always be poured into the water, and if used immediately no heating will be required. In five to ten minutes after the neck is filled the fat will have risen in a solid column and the percentage may be read the same as in case of milk bottles.

It will sometimes be noticed that in adding water to the bottles after the first whirling the fat is not clear and yellow, but light colored and muddy. This latter condition is usually caused by too little acid being used, and can be remedied by adding a little more acid, shaking and whirling the bottle again. If the fat has curd mixed with it the reading will be too high.

In ordering the bottles described above, parties should be particular to state that "cream bottle No. 3" is wanted.

We would not advise getting larger than a twenty bottle machine, and we would order two dozen graduated necks and four or five dozen bases for a machine of that size. Dealers furnishing these bottles should always fit them with the piece of rubber tubing to connect the base with the neck.

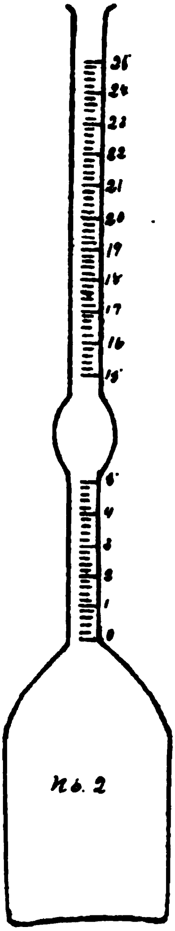
A very convenient way of handling the acid, is to have a glass stoppered burette holding three or four charges, so fastened to a shelf or stand that it can be filled by a glass stoppered syphon passing into a large acid bottle above.

This syphon is filled with acid by blowing into the bottle through a small piece of rubber tubing connected with a piece of glass tubing passing through the stopper which should fit the acid bottle perfectly.

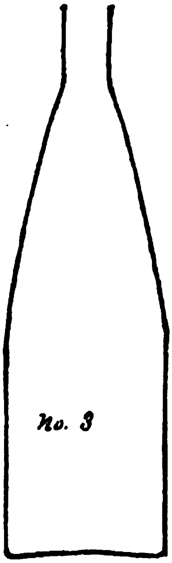
This piece of apparatus with a gallon bottle can be supplied by glass dealers for about $4.00.

For filling the bottles with hot water, we would recommend a galvanized iron tank placed above the centrifugal machine, with a faucet near the bottom to which is attached a piece of rubber tubing three feet long with a glass nozzle which can be moved around to each of the bottles where they stand in the machine.

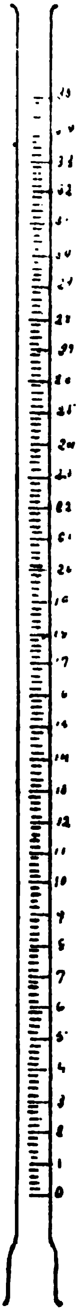
NOTE. The writer has designed a bottle for determining the fat in butter made similar to No. 3, except the middle portion of the neck is enlarged like a pipette. The small portions above and below the enlargement are graduated the same as the milk bottles. The range of readings is from 70 to 90 per cent. fat using 18 grams of butter. The efficiency of this bottle has not yet been tested.



No. 2



No. 3



THE LACTOMETER AND FAT TEST FOR CHEESE AND CONDENSED MILK FACTORIES.

Within the last few months some inquiries have been received from parties interested in cheese and condensed milk factories in regard to a test to determine the quality of the milk received at these institutions.

The fat test which very accurately tells the butter value of milk does not give its actual value for making cheese or condensed milk. For instance, a factory may require milk of a certain standard, for instance 3 per cent. fat. Such milk should contain about 9 per cent. solids not fat. A patron may have milk that contains 6 per cent. fat and 10 per cent. other solids. If he should dilute this milk 50 per cent. with water it would then contain 3 per cent. fat and appear by the fat test alone to be up to the standard, while it would be worth but little more than half as much for cheese or condensed milk because it would contain but 5 per cent. solids not fat. Therefore it is necessary to have recourse to some method to detect adulterations besides the fat test, to protect the above institutions and milk buyers in general against fraud. It seems the height of folly for our cheese and condensed milk factories to go on paying for milk by quantity without regard to quality. It is simply putting a premium on dishonesty and poor milk. For who would turn milk from a nice Jersey herd into a factory if he received only the same price per pound as his neighbor who has a herd of ordinary animals yielding milk of much less value.

The most common adulterations are the removing of cream and the addition of water. By determining the fat and the solids not fat, either or both of these adulterations are easily detected.

In many states legal standards for fat and solids not fat have been established in order to protect the public against fraud. In some states the required standard is 3 per cent. fat, others 3.5 per cent. and solids not fat about 9 per cent. Milk from a good sized herd varies but little from day to day. Milk from a single cow may vary quite widely in fat, but from a herd will seldom vary more than 0.2 or 0.3 per cent. and solids not fat even less.

It is rather difficult to fix any standard, so great is the variation in different animals, but it is very rare that the mixed milk from a large herd at any season of the year will fall below 12 per cent. total solids unless it has been diluted. Milk containing less than 9 per cent. solids not fat is suspicious, and a sample containing much less than 8.5 is probably watered. When a standard is adopted the only course to pursue is to consider all milk falling below this standard adulterated. If the milk is not up to the standard it matters not whether it is from poor cows or is diluted after milking, the results are the same.

It is necessary therefore in order to detect adulterations to determine both the fat and the other solids. For the determination of the former we would recommend the Babcock test described in Bulletin No. 3 of this Station and Bulletins Nos. 24 and 31 of Wis. Experiment Station, and then the solids not fat can be quite readily and accurately estimated from the specific gravity and per cent. of fat. The specific gravity of whole milk at 60 F. varies from 1.030 to 1.034. This means that when a certain volume of distilled water at 60 F. weighs just 1000 lbs the same volume of milk will weigh 1.030 to 1.034 lbs. The solids not fat, namely, the casein, albumen, milk, sugar and mineral matter are the constituents of milk that are heavier than water and therefore cause its greater weight. On the other hand the fat is lighter, consequently the abstraction of fat increases the specific gravity, and the addition of water decreases the specific gravity so one can readily tell whether the milk has been skimmed or diluted with water by these two tests. For example suppose a sample of whole milk contains 4.2 per cent. fat, and has a specific gravity of 1.032. If this milk were diluted one half with water it would contain 2.1 per cent. fat and have a specific gravity of about 1.016, while if it were partially skimmed to contain about 2.1 per cent. fat its specific gravity would be increased to about 1.0345.

THE LACTOMETER.

The instrument we would recommend for taking the specific gravity is the lactometer, which is sufficiently accurate for practical purposes. There are several kinds in use at the present time, all of which are made on the same general principle, viz: A narrow stem attached to an elongated bulb weighted at the bottom so that it will maintain an upright position when floating in the milk, with the stem which is graduated partially submerged.

The mark on the stem to which it sinks shows the specific gravity. The instrument we would recommend for this purpose is the Quevenne lactometer. The scale on the stem expresses in thousands the weight of the liquid in which it is placed as compared with water. The graduations are usually from 15 to 40 degrees. To illustrate, milk having a specific gravity of 1.032 would give a reading of 32 on the Lactometer and one having a specific gravity of 1,025 would give a reading of 25.

METHOD OF MAKING THE TEST.

The method of making the fat test has been already described in the bulletins referred to. To take the specific gravity with the lactometer it is necessary, 1st that milk be free from air bubbles, and in order to insure this it should stand at least one half hour after being drawn; 2nd. that it should be thoroughly mixed by pouring carefully from one vessel to another, avoiding any violent motions that would be likely to collect air bubbles, then brought to the proper temperature, 60° F., placed in a vessel of sufficient depth and diameter to allow the lactometer to float freely, and the mark on the stem to which the instrument sinks, read. In case it is not convenient to bring the milk to just the temperature of 60° F., a correction may be made where the variation is not more than 10 degrees, by adding to the lactometer reading 0.1 for each degree the temperature exceeds 60, and subtracting 0.1 for each degree below 60. For example, a lactometer reading of 32 at 65° F., corrected, would read 32.5; at 55° F., corrected, 31.5.

After finding the per cent. of fat, and taking the lactometer reading the per cent. of solids not fat may be found by the table given on the following pages.

Find the per cent. of fat in one of the vertical columns, either to the right or left of the table and the lactometer reading at the top of the table in the line of figures marked lactometer reading, then look down the column of figures directly under the lactometer reading till on line with the per cent. of fat, and the figures found at this point will be the per cent. of solids not fat in the milk.

For example, suppose the per cent. of fat is 4.5 and the lactometer reading is 32, then the per cent. of solids not fat will be 9.28. The lactometer can easily be read to half degrees when necessary to be quite accurate. Suppose the lactometer reads 31.5 instead of 32 in the above example, then the per cent. of solids not fat would be 9.15. The per cent. of solids not fat added to the per cent. of fat gives total solids.

By means of the methods given, any person of ordinary intelligence and skill, can with a little practice, readily determine the value of milk quite accurately.

After adopting the test, the factory and its patrons must agree upon some method of paying for the milk. There are two or three ways of doing this. One is to adopt a standard, say 3.5 per cent. fat, 9 per cent. other solids and fix a price for milk of this standard. Then pay for milk, testing above or below these figures, more or less in proportion as it tests. Another method is to fix the price per pound for fat and other solids, and determine by the test the number of pounds furnished by each patron. Still another is to fix the price per pound for total solids. Total solids are found by adding the percentage of fat to the percentage of solids found by the table.

Some doubtless will complain that these tests involve too much labor to be practical, but in regard to this we will say, that after one has had some practice, the time required to make the tests is much less than one would suppose. A man can easily test 20 samples in two hours for both fat and other solids. The fat test takes the greater part of the time, and that need not be made more than once a week, especially if the composite sample mentioned in "notes on cream testing" be used.

All lactometer readings must be taken before the milk sours. Quite a number of formulas have been made for estimating solids not fat from the specific gravity and the per cent. of fat, but the table here given is made from one presented by Dr. Babcock, Bulletin No. 31 Wis. Agr. Experiment Station.

The writer has made quite a large number of comparisons in determining solids by this table and by the gravity process, and finds the agreement close enough for practical purposes.

The results can be found on the following pages. The table for solids not fat is so arranged, that it can be taken from the bulletin and mounted on card board for use.

The apparatus for these tests can be obtained from most dealers in dairy supplies. The Quevenne lactometer should always be ordered to use with the table given.

LIBRARY OF THE UNIVERSITY OF CALIFORNIA.

NAME OF COW.	Fat.	Solids not Fat.	
		Gravemetric Method.	Babcock Test and Lactometer.
	%	%	%
Nancy......	2.60	8.87	8.87
(Ayershire)	3.50	8.80	8.93
	2.80	8.95	8.75
	3.60	8.89	8.90
	2.70	8.94	8.82
	3.50	8.84	8.90
	2.85	9.07	8.82
	3.50	9.16	8.90
	3.10	8.70	8.85
	2.71	8.68	8.76
	3.40	8.65	8.39
	2.80	8.56	8.60
	3.20	8.43	8.74
	2.70	8.80	8.76
Average ...	....	8.81	8.78
Dinsmore ..	4.55	9.45	9.56
(Jersey)	5.80	9.65	9.82
	5.45	9.90	9.60
	5.40	9.65	9.74
	4.10	9.74	9.60
	5.45	9.69	10.00
	4.50	9.56	9.68
	5.00	9.55	9.78
	6.10	9.49	9.62
	4.42	9.43	9.61
	5.60	9.63	9.65
	4.40	9.63	9.28
	5.15	9.59	9.68
	4.60	9.51	9.56
Average ...	....	9.61	9.65
Shaw	4.65	9.72	9.56
(Grade)	6.35	9.55	9 34
	4.60	9.86	9.83
	5.65	9.80	9.68
	5.15	9.97	9.69
	6.25	9.70	9.66
	4.80	9.82	9.74
	5.60	9.75	9.78
	6.10	9.36	9.62
	5.00	9.82	9.80
	6.00	9.50	9.60
	5.00	9.72	9.65
	5.60	9.44	9.55
	5.20	9.55	9.48
Average ...	....	9.68	9.64
Agnes	4.30	9.34	9.40
(Jersey)	5.50	9.20	9.23
	4.45	9.15	9.41
	5.15	9.25	9.43
	5.00	9.13	9.12
	4.95	9.29	9.37
	4.55	9.17	9.40
	5.30	9 30	9.56
	5.30	9.23	9.34
	4.41	9.13	9.26
	5.00	9.00	9.26
	4.50	9.33	9.15
	5.05	9.22	9.25
	4.55	9.05	9.17
Average ...	....	9.20	9.31
L. T	4.10	9.27	9.33
(Jersey)	4.80	9.11	9.32
	4.05	9.23	9.19
	4.75	9.21	9.32
	3.80	9.42	9.26
	4.50	9.36	9.35
	4.20	9.32	9.34
	4.95	9.88	9.52
	4.75	8.92	9.32
	3.83	9.06	9.26
	4.55	9.25	9.23
	3.80	9.20	9.13
	4.65	8.93	9.30
	3.85	9.18	9.26
Average ...	....	9.24	9.23
Herd.......	3.70	9.20	9.11
	3.40	8.70	8.78
	3.40	9.40	9.57
	3.20	8.70	9.00
	3.60	9.80	9.61
	4.00	9.60	9.70
P'r'ly skm'd	1.20	10.40	10.14
Watered ...	2.00	4.80	4.83
" ...	2.25	6.70	6.96
Skimmed ..	0.20	9.32	9.30

ds not fat corresponding to per cent. of fat and Quevenne lactometer reading.

LACTOMETER READING.																	Per cent. of Fat.
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
6.26	6.52	6.78	7.04	7.30	7.56	7.82	8.08	8.34	8.60	8.86	9.12	9.38	9.64	9.90	10.16	10.42	0.1
6.28	6.54	6.80	7.06	7.32	7.58	7.84	8.10	8.36	8.62	8.88	9.14	9.40	9.66	9.92	10.18	10.44	0.2
6.30	6.56	6.82	7.08	7.34	7.60	7.86	8.12	8.38	8.64	8.90	9.16	9.42	9.68	9.94	10.20	10.46	0.3
7.20	7.46	7.73	7.99	8.25	8.51	8.77	9.04	9.30	9.56	9.83	10.09	10.35	10.61	10.88	11.14	11.40	4.6
7.22	7.48	7.75	8.01	8.27	8.53	8.80	9.06	9.32	9.58	9.85	10.11	10.37	10.64	10.90	11.16	11.42	4.7
7.24	7.50	7.77	8.03	8.29	8.55	8.82	9.08	9.34	6.61	9.87	10.13	10.39	10.66	10.92	11.18	11.45	4.8
7.26	7.53	7.79	8.05	8.31	8.58	8.84	9.10	9.37	9.63	9.89	10.15	10.42	10.68	10.94	11.20	11.47	4.9
7.28	7.55	7.81	8.07	8.33	8.60	8.86	9.12	9.39	9.65	9.91	10.17	10.44	10.70	10.96	11.23	11.49	5.0
7.30	7.57	7.83	8.09	8.36	8.62	8.88	9.15	9.41	9.67	9.93	10.20	10.46	10.72	10.99	11.25	11.51	5.1
7.33	7.59	7.85	8.11	8.38	8.64	8.90	9.17	9.43	9.69	9.96	10.22	10.48	10.74	11.01	11.27	11.53	5.2
7.35	7.61	7.87	8.14	8.40	8.66	8.92	9.19	9.45	9.71	9.98	10.24	10.50	10.77	11.03	11.29	11.55	5.3
7.37	7.63	7.89	8.16	8.42	8.68	8.95	9.21	9.47	9.74	10.00	10.26	10.52	10.79	11.05	11.31	11.58	5.4
7.39	7.65	7.92	8.18	8.44	8.70	8.97	9.23	9.49	9.76	10.02	10.28	10.55	10.81	11.07	11.34	11.60	5.5
7.41	7.67	7.94	8.20	8.46	8.73	8.99	9.25	9.52	9.78	10.04	10.31	10.57	10.83	11.10	11.36	11.62	5.6
7.43	7.69	7.96	8.22	8.48	8.75	9.01	9.27	9.54	9.80	10.06	10.33	10.59	10.85	11.12	11.38	11.64	5.7
7.45	7.72	7.98	8.24	8.50	8.77	9.03	9.30	9.56	9.82	10.09	10.35	10.61	10.88	11.14	11.40	11.67	5.8
7.47	7.74	8.00	8.26	8.53	8.79	9.05	9.32	9.58	9.84	10.11	10.37	10.63	10.90	11.16	11.42	11.69	5.9
7.49	7.76	8.02	8.28	8.55	8.81	9.07	9.34	9.60	9.87	10.13	0.39	10.66	10.92	11.18	11.45	11.71	6.0
24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	

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AGRICULTURAL
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OF
CALIFORNIA.

ANNUAL REPORT

OF THE

MAINE STATE COLLEGE

FOR THE

YEAR 1893.

PART II.

PART I–Reports of Trustees, President and Treasurer.

PART II–Report of the Director of the Agricultural Experiment Station.

ANNUAL REPORT

OF THE

MAINE STATE COLLEGE

FOR THE

YEAR 1893.

PART II.

Report of the Director of the Agricultural Experiment Station.

AUGUSTA:
BURLEIGH & FLYNT, PRINTERS TO THE STATE.
1894.

MAINE STATE COLLEGE.

AGRICULTURAL EXPERIMENT STATION.

THE STATION COUNCIL.

TRUSTEE RUTILLUS ALDEN	Winthrop.
PROFESSOR WALTER BALENTINE, M. S.	Orono.
TRUSTEE BENJAMIN F. BRIGGS	Auburn.
PRESIDENT ABRAM W. HARRIS, Ph.D.	Orono.
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REPRESENTATIVE B. WALKER McKEEN, State Board of Agriculture	Fryeburg.
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THE STATION STAFF.

THE PRESIDENT.	
WHITMAN H. JORDAN, M. S.	Director.
*MERRITT C. FERNALD, PH.D	Meteorologist.
WALTER BALENTINE, M. S	Agriculturist.
JAMES M. BARTLETT, M. S	Chemist.
FRANCIS L. HARVEY, PH.D.	Botanist and Entomologist.
LUCIUS H. MERRILL, B. S	Chemist.
FREMONT L. RUSSELL, V. S	Veterinarian.
WELTON M. MUNSON, M. S	Horticulturist.
FRED P. BRIGGS, B. S	Assistant in Botany and Entomology.
HARRIS P. GOULD	Assistant in Horticulture.
ANDREW M. SHAW	Foreman in Experimental Agriculture.
MRS. J. HAMLIN WAITT	Clerk and Stenographer.

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*Resigned September 1, 1893.

TREASURER'S REPORT.

The Maine Agricultural Experiment Station in account with the United States appropriation:

RECEIPTS.

From the Treasurer of the United States as per appropriation for the year ending June 30, 1893........		$15,000 00

EXPENDITURES.

Botany and Entomology	$ 14 87	
Chemical Laboratory............................	281 47	
Expense Account	160 89	
Field and Feeding..............................	1,253 61	
Fertilizer Inspection	134 80	
Horticultural Department	689 56	
Meteorology	30 70	
Printing	1,458 79	
Construction and Repairs.......................	186 04	
Stationery and Postage.........................	93 95	
Traveling Expenses	135 35	
Library..	120 85	
Veterinary Science.............................	5 40	
Fuel...	140 82	
World's Fair...................................	501 87	
Trustee Expenses...............................	16 00	
Water Supply...................................	200 00	
Salaries.......................................	9,574 97	
		$14,999 94

I hereby certify that the above is a correct statement of the amount expended by the Maine Experiment Station for the year ending June 30, 1893.

G. H. HAMLIN, TREASURER,

Trustees of Maine State College of Agr. and the Mech. Arts.

I hereby certify that I have examined the accounts of the Maine Experiment Station for the fiscal year ending June 30, 1893; that I have found the above to be a correct statement of expenditures both as to amount and classification, for all of which, proper vouchers are on file.

HENRY LORD, AUDITOR,

Trustees of Maine State College of Agr. and the Mech. Arts.

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DIRECTOR'S REPORT.

A. W. Harris, Ph. D., President Maine State College.

SIR:—I submit herewith a report of the work performed in the various departments of the Experiment Station for the year 1893:

It is hoped that the facts and discussions therein presented will prove of value to the agriculture of the State, through a careful consideration of their relations to farm practice.

The past year has been one of general prosperity in the affairs of the Station. In one direction, at least, as will be seen by subsequent statements, an addition of equipment and enlargement of work have been made which give promise of results of great value. Better than anything else which could be mentioned, perhaps, is the increasing evidence that the Station is exerting a positively helpful influence in the agricultural affairs of Maine. The large correspondence which has grown up between the Station officers and the farmer citizens of the State, the numerous appeals for aid in various directions and the cordial and sympathetic reception which representatives of the Station receive at farmers' institutes and other public meetings may not only constitute substantial reasons for encouragement, but may also convey to each member of the Station staff a sense of personal gratification. I wish to express in behalf of myself and my associates a grateful appreciation of the pleasant relations which we have come to sustain toward a large number of leading Maine farmers, and of the cordial co-operation of the Board of Agriculture, the State Pomological Society and the Patrons of Husbandry.

FERTILIZER INSPECTION.

The Maine legislature of 1893 enacted a new law for the control of the sale and inspection of commercial fertilizers, of which the Director of this Station is made the executive officer. This work will necessarily and properly be done at the Station.

It is provided that an analysis fee of fifteen dollars shall be paid by the manufacturers, importers or dealers for each distinct brand of fertilizer of which more than thirty tons are sold in Maine, the income thus derived to be used to pay the expenses of the fertilizer inspection and publishing the results. It is even now very evident that this fee is too small. In fact, the experience of ten or twelve years had previously shown that a fee of at least $20 would be needed. It is hoped that the legislature of 1895 will remedy this error by increasing the fee.

THE NEW FORCING HOUSE.

The most notable addition to the Station equipment is the new forcing house, now nearing completion, which is to be used in the study of problems in plant nutrition. The work is to be under the immediate charge of Professor Balentine, who reports on subsequent pages the results of experiments made in the forcing house erected several years since. It is believed that in giving more attention to a scientific study of certain phases of plant nutrition the Station will occupy a field very largely neglected by American experiment stations, this line of study having so far held a place much subordinate to animal nutrition. The new house is 65x18 feet. and is to be equipped in a manner best adapted to its intended purpose.

INCREASE OF MAILING LIST.

At a meeting of the Station Council in the autumn of 1892, it was urged that the list of farmers receiving the publications of the Station should be increased. This matter was left with me for action. After considering several plans, I decided to send to each postmaster in the State a card-board poster showing a cut of the College buildings, and stating thereon that the station publications would be sent free to any Maine farmer requesting them. Through such advertising and by other means that have been adopted, the mailing list of residents of this State has been increased over two thousand names, so that now it numbers between seven and eight thousand. It is doubtful if a larger proportion of the farmers of any state are receiving the bulletins of their experiment station than is the case in Maine. During the year the mailing list has also been revised by sending to each postmaster for correction a list of names previously addressed to his office. In this way a large number of errors were corrected.

STATION PUBLICATIONS.

The large increase that has been made to the mailing list has rendered it necessary to consider the most economical methods of preparing and distributing Station publications. It is very desirable, also, that the manner of presenting the results of experiments and investigations shall be such as to secure for them wide attention. Experience has shown that in order to accomplish this, the statements made by Station officers must be as concise and simple as is consistent with accuracy. On the other hand, it is very important that a certain class of readers, such as other station workers and the farmers who possess scientific knowledge and training, shall have access to a full record of the data upon which are based the conclusions that stand in close relation to farm practice. In view of the foregoing considerations, it has been decided to issue numerous short bulletins, of not over four pages each, which shall be sent to the entire mailing list, and which shall present to the reader, in a form adapted to the unscientific public, all the results of Station work which have an immediate relation to farm practice. There will also be issued an annual report which shall contain a complete record of the doings of the Station, stated in part at least, in a somewhat scientific and technical form. It is proposed that this annual report shall have a circulation limited to the officers and staffs of other stations, certain exchange publications and such farmers as shall specially request that it be sent to them.

ACKNOWLEDGMENTS.

I append a statement of gifts made to the Station, and publications received by the Station free of charge. I wish to make our acknowledgment for these favors.

W. H. JORDAN, *Director.*

MAINE STATE COLLEGE,
ORONO, ME., Dec. 31, 1893.

Donations to the Horticultural Department, 1893.

J. M. Thorburn & Co., New York, N. Y., vegetable seeds.

W. Attle Burpee, Philadelphia, Pa., miscellaneous vegetable and flower seeds.

J. J. H. Gregory & Son, Marblehead, Mass., vegetable seeds.

U. S. Department of Agriculture, Washington, D. C., vegetable seeds, cions, cuttings.

Cornell University, Ithaca, N. Y., cuttings of Russian willows and poplars.

A. M. Smith, St. Catherines, Ontario, six plants Pearl gooseberry.

H. S. Anderson, Union Springs, N. Y., three plants Frontenac gooseberry.

Benjamin F. Sill, Long Island City, N. Y., one rubber plant sprinkler.

Gould's Manufacturing Co., Seneca Falls, N. Y., one Knapsack spraying pump.

The following newspapers and other publications are kindly donated to the Station by the publishers during 1893-4:

Farmers' Home, Dayton, Ohio.
Holstein Friesian Register, Boston, Mass.
Farm and Home, Springfield, Mass.
Jersey Bulletin, Indianapolis, Ind.
Monthly Bulletin, Philadelphia, Pa.
Farmers' Advocate, London, Ont.
Maine Farmer, Augusta, Maine.
Southern Cultivator, Atlanta, Ga.
American Dairyman, New York, N. Y.
The Sun, Baltimore, Md.
Massachusetts Ploughman, Boston, Mass.
Practical Farmer, Philadelphia, Pa.

New England Farmer, Boston, Mass.
Louisiana Planter, New Orleans, La.
Mirror and Farmer, Manchester, N. H.
Texas Farmer, Dallas, Texas.
Hoard's Dairyman, Fort Atkinson, Wis.
Iowa Farmer and Breeder, Cedar Rapids, Iowa.
Detroit Free Press, Detroit, Mich.
Orange County Farmer, Port Jervis, N. Y.
Farm Journal, Philadelphia, Pa.
Delaware Farm and Home, Wilmington, Del.
The Western Rural, Chicago, Ill.
American Cultivator, Boston, Mass.
Farmers' Review, Chicago, Ill.
The Rural Canadian, Toronto, Ont.
Vick's Magazine, Rochester, N. Y.
The Farm and Dairy, Ames, Iowa.
The Clover Leaf, South Bend, Ind.
New York World. (Weekly.)
The Grange Visitor, Lansing, Mich.
The Industrial American, Lexington, Ky.
The American Grange Bulletin and Scientific Farmer, Cincinnati, Ohio.
Agricultural Epitomist, Indianapolis, Ind.
The Prairie Farmer, Chicago, Ill.
Northern Leader, Fort Fairfield, Me.
Farm Life, Rochester, N. Y.
American Agriculturist, New York.
American Creamery, Chicago, Ill.

Investigation on the Foraging Powers of Some Agricultural Plants for Phosphoric Acid.

WALTER BALENTINE.

Of recent investigations in plant nutrition those establishing the fact that leguminous plants are able to gather a portion of their nitrogen either directly or indirectly from the free nitrogen of the air are by far the most important, both from the scientific and the practical stand points.

These investigations settle a question that has attracted the attention of agricultural chemists for half a century. On the practical side the results enable us to say, that it is possible, by growing and feeding to farm animals such plants as peas and clover, to increase the stock of nitrogen for manurial purposes without resorting to the various expensive commercial nitrogenous materials.

Stating the results of these investigations concisely, it has been found that the leguminous plants are able to forage on the atmosphere for a portion of their nitrogen. Other plants either possess this power to a much less degree or not at all. If we look for a reason why this family of plants has attracted so much attention from scientists we find it in the fact that some of its members, the clovers especially, have been found in practical farming to be plants which by their growth on the soil, apparently leave it richer in plant food than before, and that farmers are actually able to produce more of grass, grain and potatoes when clover is used as one of the crops in rotation. It was to learn why a plant that takes up such large quantities of nitrogen as clover, should still leave the ground in a better condition for succeeding crops, that the sources of supply of nitrogen to the leguminous plants have been so carefully studied.

The value of the results of this work to the agriculture of the world cannot be over-estimated. There are, however, other problems in plant nutrition which deserve as careful study as the nitrogen question and which may yield results of equal practical importance.

All who have given especial attention to the subject of plant nutrition will, undoubtedly, agree that the foraging powers of plants for the elements contained in the ash, vary greatly. This fact is recognized by the majority of observing farmers, as is shown by the following common sayings: Wheat requires a rich soil." "Corn is a grass feeder." "Oats are an exhaustive crop."

Notwithstanding that these views regarding the variation in foraging powers of different crops have been held by many for years, no one is prepared to say just how it is exerted. We are hardly ready to express an opinion whether the greater vigor of certain plants as compared to other species grown on the same soil is due to their superior foraging powers for all of the elements contained in their ash, or for one or more particular elements.

It seems quite as likely, however, that some plants are able to use certain soil compounds of potash or phosphoric acid, which are not available to other plants, as it did that the legumes were able to obtain nitrogen from sources that were not available to the grasses.

Believing that a study of the foraging powers of different agricultural plants would reveal facts of scientific interest, and at the same time of practical value to agriculture, the writer commenced a series of experiments, in the fall of 1892, designed to test the readiness with which different plants obtain their phosphoric acid from insoluble phosphates.

The reason why phosphoric acid was selected on which to make these first studies, in preference to any other substance was, that in practical manuring with crude phosphates, and also in their use in experimental work, different crops had apparently showed decided differences in their abilities to gather phosphoric acid from such a source.

EXPERIMENTAL METHODS.

In order to have the work as much as possible under control the experiments were conducted in boxes in the college forcing house. These boxes were of wood, fifteen inches square and twelve inches deep. For soil a fine sand was used, taken from a sand bank about three feet below the surface. This sand was drawn to the forcing house, screened and thoroughly mixed by repeatedly shoveling it over, after which a sample was taken and the content of potash and phosphoric acid determined, with the following result: Potash, 0.096 per cent; phosphoric acid, 0.012 per cent.

One hundred and twenty pounds of sand were used in each box.

For each kind of plant studied nine boxes were used, in three sets of three boxes each.

The three boxes of each set received the following manuring per box:

SET I
8.5 grams nitrate of soda = 1.36 grams nitrogen.
2.6 grams muriate of potash = 1.36 grams potash.

SET II
8.5 grams nitrate of soda = 1.36 grams nitrogen.
2.6 grams muriate of potash = 1.36 grams potash.
17.0 grams South Carolina rock = 3.96 grams insoluble phosphoric acid. 0.39 grams citrate soluble phosphoric acid.

SET III
8.5 grams nitrate of soda = 1.36 grams nitrogen.
2.6 grams muriate of potash = 1.36 grams potash.
28.5 grams acidulated South Carolina rock = 3.34 grams soluble phosphoric acid. 0.50 grams citrate soluble phosphoric acid. 0.62 grams insoluble phosphoric acid.

It will be seen that all of the boxes were treated alike with reference to potash and nitrogen, that the plants grown in Set I were dependent on the phosphoric acid originally in the sand, that those grown in Set II had in addition 4.32 grams of phosphoric acid, mostly insoluble, supplied by crude finely ground South Carolina rock, and that those grown in the boxes of Set III had in addition to that originally contained in the sand 4.46 grams of phosphoric acid, mostly soluble, supplied in acidulated South Carolina rock.

The plants thus far studied have been wheat, barley, corn, beans, peas, potatoes and turnips.

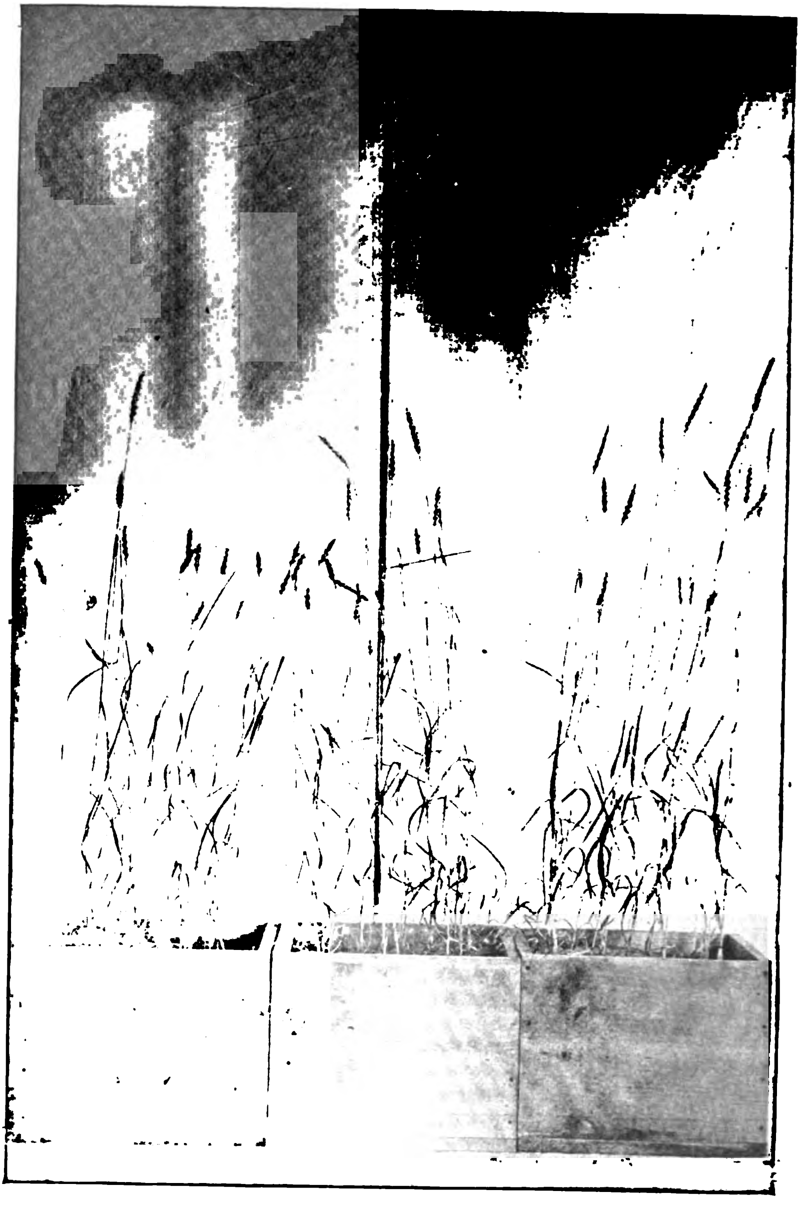
Wheat was planted in the boxes of Set I A, Set II A and III A.
Barley " " Set I B, Set II B and III B.
Corn " " Set I C, Set II C and III C.
Beans " " Set I D, Set II D and III D.
Peas " " Set I E, Set II E and III E.
Potatoes " " Set I F, Set II F and III F.
Turnips " " Set I G, Set II G and III G.

After planting, the boxes were under the care of a man experienced in growing plants under glass. Water was supplied as it was believed to be needed. At the proper time the plants were thinned so that the boxes having the same kind of plants contained the same number of plants to the box.

The plants were allowed to grow to maturity. Immediately before harvesting, the crops were photographed and plates made showing the relative development of the plants produced. At the time of harvesting, the crops of wheat, barley, corn, peas and beans produced in each box were weighed separately in an air dry condition, after which the amount of dry matter was determined in the combined crop of the three boxes of each set. In the combined crop of each set the nitrogen was determined as well as the phosphoric acid, potash and other mineral matters.

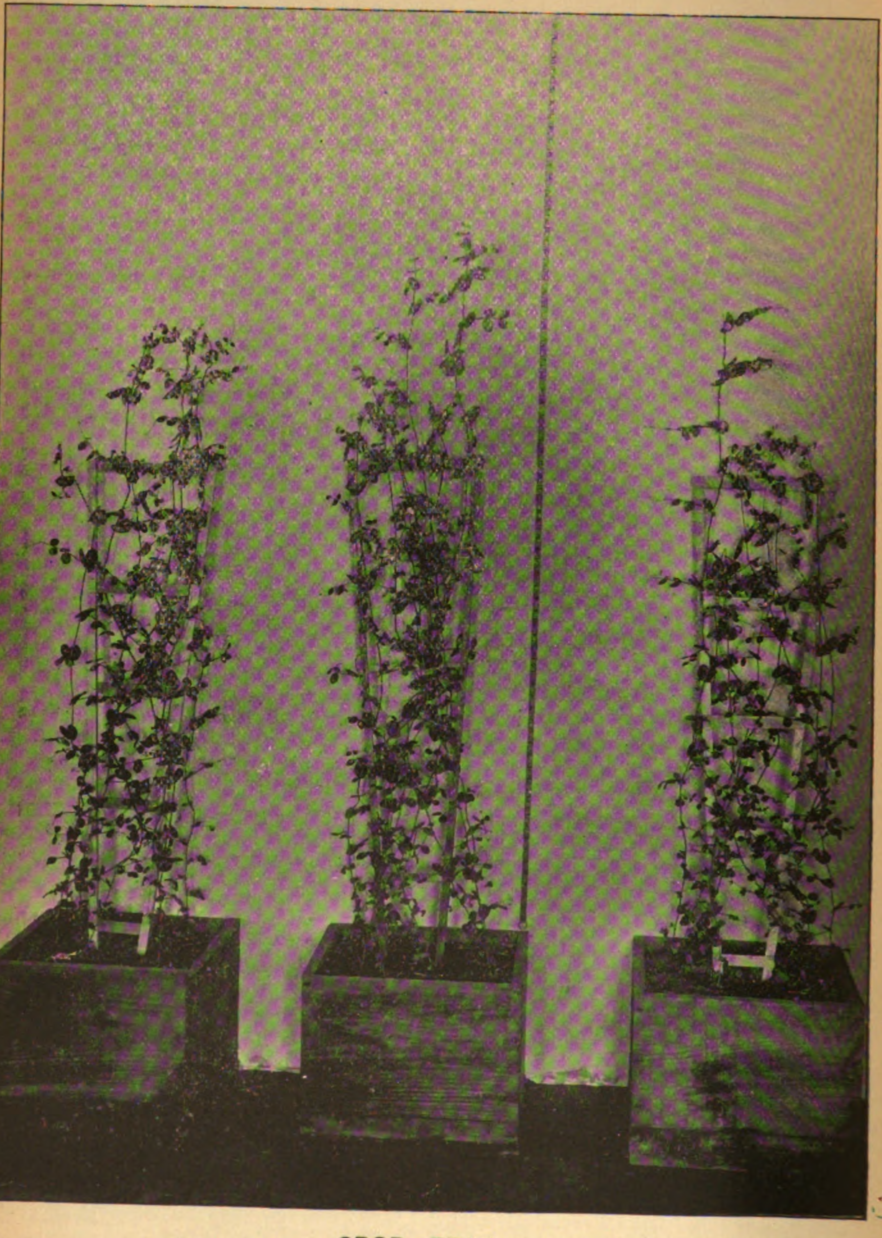
With the pototoes and turnips the crops were weighed fresh at harvesting. In other respects these crops were treated like the others.

The results of this investigation are shown in the following tables with the accompanying plates:



CROP, WHEAT.

Manure,—Nitrate of Soda, Muriate of Potash.



CROP, PEAS.

Manure,— Nitrate of Soda, Muriate of Potash.

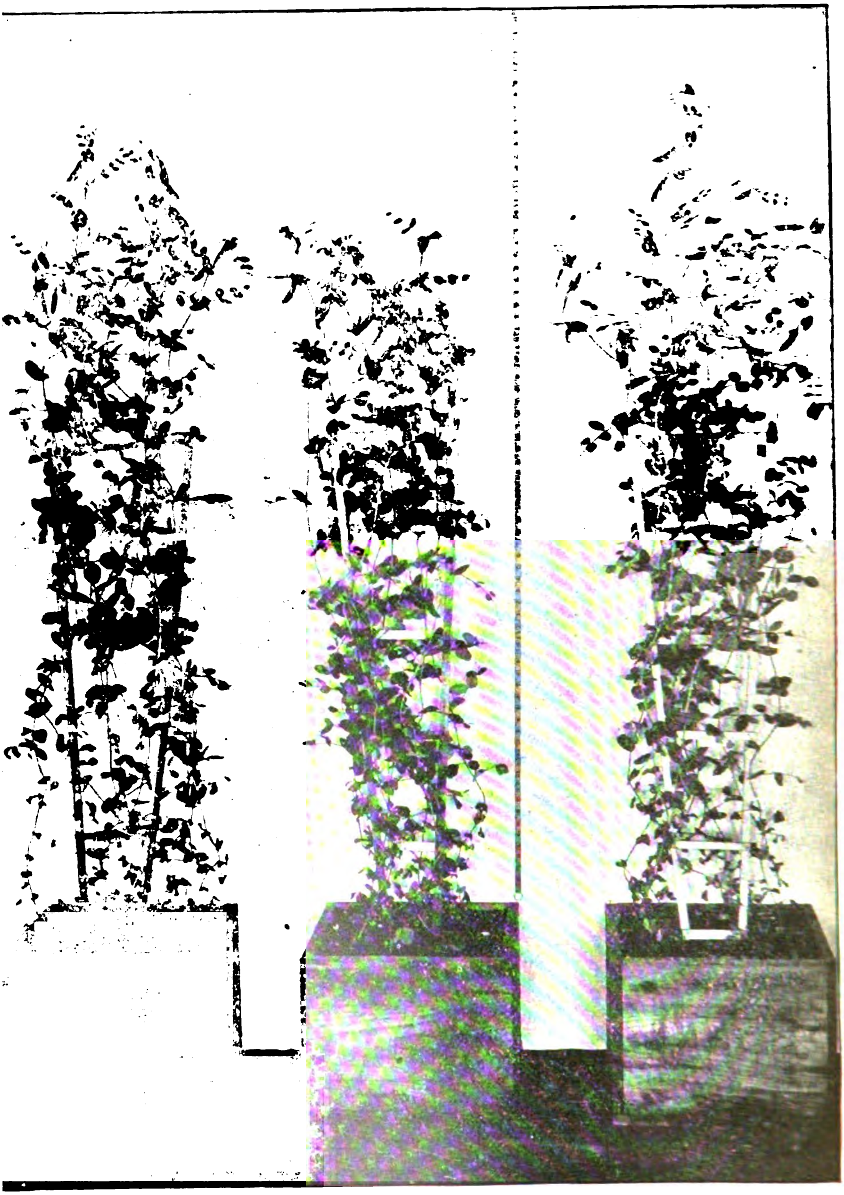
TABLE III.

EXPERIMENT WITH CORN.

Set.	Manure per box.	No. of box.	Total crop.
I C..	Nitrate of soda, 8.5 grams, and muriate of potash, 2.6 grams.	1	15.0 grams
		2	15.0 grams
		3	15.0 grams
		Total..	45.0 grams
II C..	Nitrate of soda, 8.5 grams, muriate of potash, 2.6 grams, and South Carolina rock, 17.0 grams.	1	46.0 grams
		2	53.0 grams
		3	29.0 grams
		Total..	128.0 grams
III C..	Nitrate of soda, 8.5 grams, muriate of potash, 2.6 grams, and acidulated South Carolina rock, 28.5 grams.	1	164.0 grams
		2	129.0 grams
		3	129.0 grams
		Total..	422.0 grams

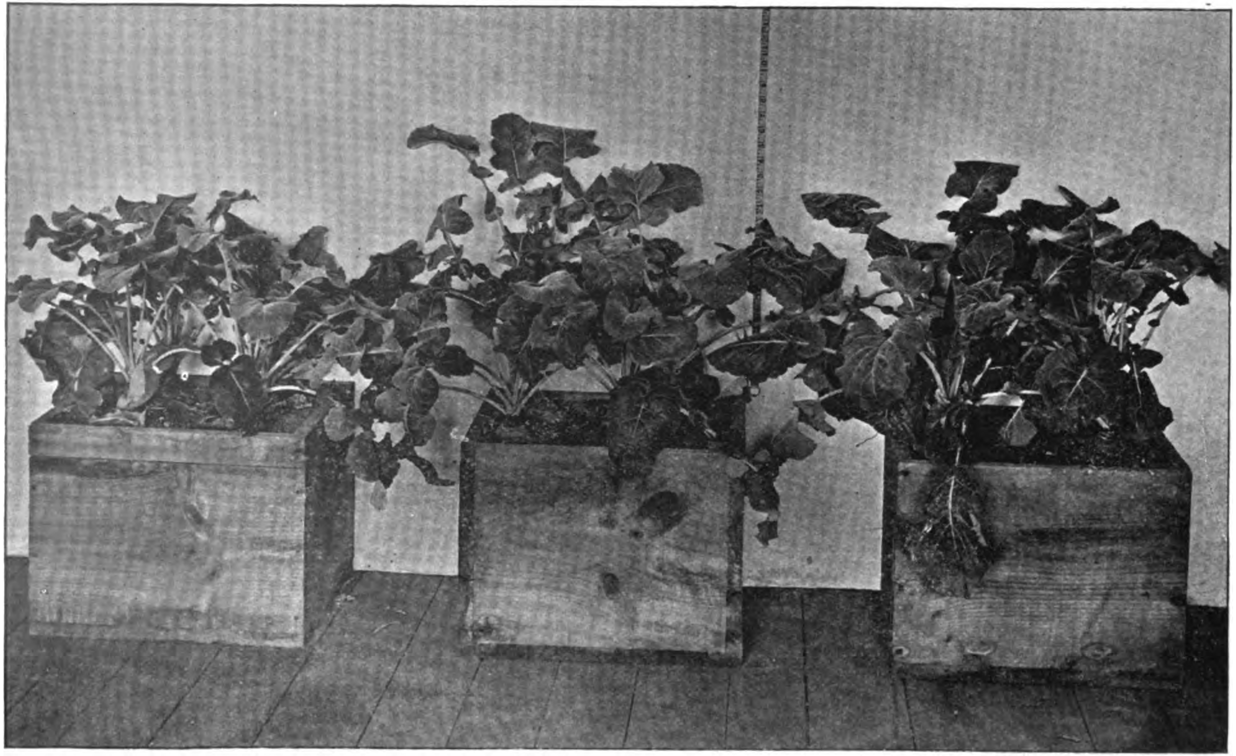
Dry matter.

Set I C	39.5 grams
Set II C	103.3 grams
Set III C	291.0 grams



CROP, PEAS.

Manure, — Nitrate of Soda, Muriate of Potash, S. C. Rock Phosphate.



CROP, TURNIPS.

Manure,—Nitrate of Soda, Muriate of Potash, Acidulated S. C. Rock Phosphate.

TABLE V.

EXPERIMENT WITH PEAS.

Set.	Manure per box.	No. of box.	Total crop.	Peas in pod.
I E..	Nitrate of soda, 8.5 grams, and muriate of potash, 2.6 grams.	1	35 grams	7 grams
		2	41 grams	11 grams
		3	45 grams	14 grams
		Total..	121 grams	32 grams
II E..	Nitrate of soda, 8.5 grams, muriate of potash, 2.6 grams, and South Carolina rock, 17.0 grams.	1	73 grams	16 grams
		2	68 grams	17 grams
		3	70 grams	17 grams
		Total..	221 grams	50 grams
III E..	Nitrate of soda, 8.5 grams, muriate of potash, 2.6 grams, and acidulated South Carolina rock, 28.5 grams.	1	83 grams	16 grams
		2	78 grams	17 grams
		3	84 grams	18 grams
		Total..	245 grams	51 grams

Dry matter.

Set I E..	112.7 grams
Set II E..	196.7 grams
Set III E..	228.6 grams

The following table gives a partial chemical analysis of the total crop produced in each set of boxes, calculated on the water free substance.

TABLE VIII.

ANALYSIS OF ENTIRE CROP CALCULATED TO A WATER FREE BASIS.

	Nitrogen. N.—%.	Ash—%.	Sand and silica—%.	Potash K_2O—%.	Soda Na_2O—%.	Iron and alumina Fl_2O_3 Al_2O_3—%.	Phosphoric acid P_2O_5—%.	Sulphuric acid SO_3—%.	Chlorine Cl—%.
Wheat, Set I A.	1.36	4.19	1.23	1.37	.08	.24	.14	.14	.36
II A.	1.34	4.05	1.27	1.29	.13	.21	.21	.17	.34
III A.	1.28	4.87	1.95	1.23	.07	.31	.39	.25	.30
Barley, Set I B.	1.65	8.19	.60	3.13	.49	.27	.20	.14	2.24
II B.	1.48	7.61	1.18	2.71	.44	.29	.19	.20	1.76
III B.	1.57	9.23	.83	2.33	1.62	.14	.29	.40	2.60
Corn, Set I C.	1.55	9.33	5.03	1.35	.05	–	.21	.16	.20
II C.	1.49	6.85	3.31	1.31	.08	.38	.27	.17	.21
III C.	0.84	5.40	1.47	1.79	.10	.21	.29	.19	.49
Beans, Set I D.	3.75	19.23	9.63	1.98	.16	–	.27	.23	
II D.	3.65	18.50	8.99	1.92	.18	–	.31	.27	
III D.	2.80	12.43	4.52	2.16	.07	.49	.41	.26	.59
Peas, Set I E.	2.52	8.34	.76	2.03	.28	.17	.30	.18	.91
II E.	2.37	9.57	1.17	2.26	.33	.37	.30	.20	.98
III E.	2.19	9.05	.71	2.23	.34	.61	.28	.30	1.03
Potatoes, Set I F.	1.69	11.46	5.88	2.79	.11	.55	.28	.23	.45
II F.	2.02	10.62	4.28	2.95	.14	.47	.29	.32	.51
III F.	2.03	11.94	4.34	3.49	.21	.39	.40	.29	.69
Turnips, Set I G.	2.87	12.30	1.03	3.22	1.03	.25	.48	.20	1.38
II G.	2.75	12.50	1.79	3.18	1.62	.23	.70	.40	1.28
III G.	3.37	13.33	1.01	3.60	1.89	.22	.76	1.20	1.22

While it may not be desirable to draw definite conclusions from so small an amount of data as is furnished by the above described experiments, there are some points which under the conditions of these experiments the results appear to bring out sharply.

1st. Different crops showed a decided difference in their powers of obtaining phosphoric acid from crude, finely ground South Carolina rock. Wheat, barley, corn, peas and turnips apparently appropriated the insoluble phosphoric acid from this source with greater or less ease, while beans and potatoes derived no benefit from it.

2d. The greatest practical advantage derived from the use of fine-ground South Carolina rock was with the turnips. With this crop a larger weight of dry matter and also a larger weight of fresh roots was obtained with insoluble phosphoric acid from the finely ground South Carolina rock than with an equal amount of soluble phosphoric acid from acidulated South Carolina rock.

3d. The indications point to a profitable use of finely ground South Carolina rock as a manure for barley and peas as well as turnips.

4th. The acidulated South Carolina rock in these experiments apparently depressed the yield of grain with barley while largely increasing the amount of straw. With wheat both grain and straw were largely increased and in about the same proportion.

ANALYSES OF CATTLE FOODS.

W. H. JORDAN, J. M. BARTLETT, L. H. MERRILL.

NOTE—The experiments in connection with which these analyses were made were planned largely by the Station Director. The analyses were entirely executed by the Station chemists. The Director is responsible for this discussion of the results.

It seems proper, because of certain views now held by agricultural chemists, that the following statement of the analyses of various cattle foods should be accompanied by explanations.

The opinion is now frequently expressed that to continue the analysis of our common cattle foods after the existing usual methods, simply for the sake of analysis, is largely a waste of time. This opinion is undoubtedly correct, and for the following reasons: 1st. Enough analyses have been made to establish the average composition of our common feeding stuffs as closely as is practicable or useful. Additional analyses will change the general averages very little.

2nd. Existing methods of food analysis are furnishing no new information about food compounds and are entirely inadequate to aid in solving the problems in animal nutrition which now most urgently demand consideration.

There is an increasing need for a more intimate study of the properties of the individual compounds of cattle foods and their relation to nutritive processes.

Nevertheless, analyses of the foods involved in experimental work even by our confessedly unsatisfactory methods, are both necessary and useful, because they disclose certain facts which are fundamental conditions, and a knowledge of which is essential to successful plans and to any well grounded conclusions.

The analyses herewith reported have nearly all been occasioned by experimental work either in studying crop production or along the line of animal nutrition. However, some attempt has been made to step outside the beaten path by endeavoring to ascertain the amount present of those carbohydrates whose properties and functions are to a large degree understood. Certain sugars and the starchs are among our best known vegetable compounds, not only as to their constitution but also as to their offices in the animal body. We have every reason to regard them as the most valuable of the nutrients usually classed under the term "nitrogen-free-extract," and it is reasonable to believe that the nutritive value of this nitrogen-free-extract varies materially according as it contains largely such compounds as sucrose, glucose and starch, which are entirely digestible and directly useful, or is almost wholly made up of bodies of which we have scanty knowledge, the little we do know not being favorable to their efficiency as food. Therefore in the experiments which this Station has made with the corn crop, not only have the regular analyses been performed, but the amounts of sugars and starch have been ascertained as closely as existing methods would allow.

THE COMPOSITION OF FODDERS AND SILAGE FROM THE CORN (MAIZE) PLANT.

The analyses which appear below have been made during the past three years in connection with experiments in the value of the corn plant as a source of cattle food. They have been necessary in order to know the amount and general character of the dry matter produced, and have been required in the digestion and feeding experiments.

TABLE IX.

COMPOSITION OF CORN FODDER AND CORN SILAGE FROM CORN GROWN ON THE STATION EXPERIMENTAL PLATS.

	Parts in 100 of the Green or Air-Dry Material.						Parts in 100 of the Water-Free Material.				
	Water.	Ash.	Protein—N×6.25.	Fiber.	Nitrogen-free-extract.	Fat.	Ash.	Protein.	Fiber.	Nitrogen-free-extract.	Fat.
Crop of 1891.											
CXLVII—Southern Corn, large white, immature, no ears	86.48	.99	1.70	4.33	6.22	.28	7.31	12.25	32.06	46.32	2.06
CXLVI—Maine Field Corn, mature, kernels glazed	86.48	.84	1.70	4.13	6.57	.28	6.25	12.22	30.56	48.95	2.02
CXLVIII—Sweet Corn, mature	86.19	.87	1.92	3.91	6.73	.45	6.29	13.96	27.74	48.72	3.29
Crop of 1892.											
CLX—Southern Corn, large white, immature, no ears	85.33	1.21	1.78	4.03	7.37	.28	8.24	12.14	27.45	50.22	1.95
CLXI—Southern Corn, large white, immature, no ears	85.85	1.04	1.75	4.08	6.93	.36	7.38	12.24	28.86	48.96	2.56
CLXII—Maine Field Corn, mature, kernels partly glazed	79.11	1.25	2.26	3.86	12.84	.68	5.98	10.83	18.48	61.46	3.25
CLXIII—Maine Field Corn, mature, kernels partly glazed	81.38	1.10	2.15	3.92	10.93	.52	5.89	11.53	21.04	58.74	2.80
CLXX—Southern Corn silage, from CLX	86.50	1.11	1.69	4.03	6.30	.37	8.21	12.52	29.85	46.64	2.78
CLXXVI—Southern Corn silage, from CLXI	83.80	1.03	2.60	4.89	6.94	.74	6.35	16.02	30.17	42.84	4.62
CLXXI—Maine Field Corn silage, from CLXII	77.70	1.28	2.25	4.73	13.23	.81	5.74	10.10	21.21	59.31	3.64
CLXXIII—Maine Field Corn silage, from CLXIII	79.60	.97	2.09	4.72	11.81	.81	4.74	10.23	23.13	57.91	3.99
Crop of 1893.											
CCXXIV—Southern Corn, large white, immature, no ears	84.55	1.29	1.57	4.35	7.90	.34	8.34	10.16	28.18	51.10	2.22
CCXXV—Southern Corn, large white, immature, no ears	83.42	1.17	2.04	4.36	8.62	.39	7.06	12.32	26.31	51.94	2.37
CCXXVI—Maine Field Corn, mature, kernels partly glazed	80.51	1.25	2.37	4.10	11.27	.50	6.41	12.16	21.06	57.81	2.56
CCXXVII—Maine Field Corn, cut August 15th, immature, no kernels formed	88.29	1.09	1.75	3.10	5.46	.30	9.33	14.96	26.51	46.60	2.60
CCXXVIII—Maine Field Corn, cut August 28th	82.50	1.14	2.05	4.08	9.71	.52	6.50	11.74	23.31	55.50	2.95
CCXXIX—Maine Field Corn, cut September 4th	80.45	1.21	2.22	3.85	11.68	.59	6.21	11.38	19.67	59.74	3.00
CCXXX—Maine Field Corn, cut September 12th	76.83	1.29	2.22	4.48	14.50	.68	5.58	9.57	19.33	62.52	3.00
CCXXXI—Maine Field Corn, cut September 21st, mature, kernels partly glazed, rapidly dried	74.66	1.50	2.34	4.71	16.04	.75	5.91	9.23	18.60	63.30	2.96
CCXXXII—Maine Field Corn, same as CCXXXI, dried slowly, without heat	78.24	1.55	2.29	4.67	12.63	.62	7.14	10.54	21.39	58.08	2.85

The above mass of figures give information on two points which are worthy of consideration by Maine farmers; viz: (1) The comparative composition of the large Southern varieties of corn, which are so often grown in Maine for fodder purposes, and the Northern field corn such as matures in Maine, which is regarded by many as the more valuable variety for use in this State.

(2) The effect of the degree of maturity of the corn plant upon its composition. The large varieties of corn *must* be cut in this State when very immature, and our own small field corn *may* be cut in any stage of maturity. What is the effect of immaturity upon the value of the plant as a food?

THE COMPARATIVE COMPOSITION OF THE LARGE SOUTHERN CORN AND THE SMALLER MAINE FIELD CORN, THE FORMER IMMATURE WHEN CUT AND THE LATTER MATURE.

Observations on these two varieties of corn have been made for five years and in the averages given below, there are included analyses already published in the reports of this Station for 1889 and 1891. The analyses for the years 1888, 1890 and 1891 are averaged separately from those of 1892 and 1893 for the reason that the samples for the first three years were obtained in a way that probably allowed a material change in their composition. In 1888, 1890 and 1891 several hundred pounds of the green plant were stored under cover in such a manner as to partially air-dry without any apparent fermentation or decay, and the fodder was not analyzed until it had stood in this condition for several months, when it was used for digestion experiments. Doubtless these fodders had suffered changes incident to the slow drying of large succulent plants, even under the most favorable conditions. In 1892 and 1893, immediately upon cutting in the field, several hundred pounds of the perfectly fresh material were finely chopped and crushed, a portion of which was rapidly dried in a steam closet. Facts given later indicate that the latter method of procedure much more fully preserved the original condition of the plant than the former, and so the analyses for the last two years are the more trustworthy as a means of ascertaining the nature of the growth which actually occurred.

It should be remarked, also that while the crops of Maine field corn must be regarded as mature in 1888, 1889 and 1890, they were much more heavily eared in 1892 and 1893.

TABLE X.

RELATIVE COMPOSITION OF TWO VARIETIES OF CORN (GREEN).

	In 100 parts fresh substance.						
Crops of 1888, 1890 and 1891—Average.	Water.	Dry substance.	Ash.	Protein N × 6.25.	Fiber.	Nitrogen-free-extract	Fat.
Southern Corn, immature	86.41	13.59	1.05	1.61	4.28	6.30	.35
Maine Field Corn, mature	84.43	15.57	1.13	1.92	4.39	7.73	.40
Excess in Field Corn......	-	1.98	.08	.31	.11	1.43	.05
Crops of 1892 and 1893—Average.							
Southern Corn, immature...........	84.80	15.20	1.18	1.78	4.20	7.70	.34
Maine Field Corn, mature	78.91	21.09	1.28	2.28	4.15	12.77	.61
Excess in Field Corn	-	5.89	.10	.50	—.05	5.07	.27

It appears from these averages that under the conditions existing in Maine, which require the cutting of the large varieties of corn in an immature state, the Maine field corn which reaches maturity, contains the larger percentage of dry matter. This is true especially of the years 1892 and 1893, when the latter crop was more perfectly developed. Again, the excess of dry matter in the Maine field corn consists almost wholly of the non-nitrogenous compounds classed under the head of nitrogen-free-extract. The characteristic differences in the composition of the dry substance of the two varieties of corn are more clearly seen by a comparison in the water-free condition.

TABLE XI.

COMPOSITION OF THE WATER-FREE SUBSTANCE OF TWO VARIETIES OF CORN.

	In 100 parts water-free substance.				
Average for 1892 and 1893.	Ash.	Protein.	Fiber.	Nitrogen-free-extract.	Fat.
Southern Corn, immature	7.76	11.72	27.70	50.54	2.28
Maine Field Corn, mature	6.05	10.94	19.79	60.33	2.89
Differences.................................. ...	+.71	+.78	+7.91	—9.89	—.61

The dry substance of the larger and immature corn contains more ash protein and fiber and less nitrogen-free-extract and fat. The much larger percentage of fiber and greatly less percentage of nitrogen-free-extract are the noteworthy differences.

THE INFLUENCE OF MATURITY UPON THE COMPOSITION OF THE CORN PLANT.

The figures above cited compare two varieties of corn in unlike stages of maturity and show important differences in composition. Is this a question of maturity or of variety? In order to obtain testimony on this point, in 1893 field No. 1 of Maine field corn was cut in five different lots, ranging in times of cutting from August 15th to September 21st, and in stage of growth from the early formation of the ear to full maturity. The analyses of samples from these different cuttings appear in Table 1 but are reproduced below.

TABLE XII.

COMPOSITION OF CORN CUT AT DIFFERENT PERIODS OF GROWTH.

	In 100 parts fresh substance.						
	Water.	Dry substance.	Ash.	Protein N × 6.25.	Fiber.	Nitrogen-free-extract.	Fat.
Maine Field Corn, cut August 15th..	88.29	11.71	1.09	1.75	3.10	5.46	.30
August 28th..	82.50	17.50	1.14	2.05	4.08	9.71	.52
Sept. 4th	80.45	19.55	1.21	2.22	3.85	11.68	.59
Sept. 12th....	76.83	23.17	1.29	2.22	4.48	14.50	.68
Sept. 21st	74.66	25.34	1.50	2.34	4.71	16.04	.75

The immature and mature corn differ in the following essential particulars:

(1) The mature corn is less watery: i. e. it contains a much larger percentage of dry substance. During the thirty days before the mature crop was harvested there was a continuous and large increase in the percentage of dry matter. It will appear later that this was due to an actual growth of dry matter, rather to a drying out of the water with a diminished weight of crop.

(2) This increase was most largely from the growth of compounds classed as nitrogen-free-extract, such as starch, sugar and allied bodies.

This is most clearly shown by the arrangement of figures in Table 13:

TABLE XIII.

RELATION OF DIFFERENT CLASSES OF COMPOUNDS IN CORN CUT AT DIFFERENT PERIODS OF GROWTH.

	In 100 pounds of green corn as cut.		
	Pounds of dry matter.	Pounds of nitrogen-free-extract.	Pounds of all compounds other than nitrogen-free-extract.
Lot cut August 15th, very immature	11.71	5.46	6.25
August 28th	17.50	9.71	7.79
September 4th	19.55	11.68	7.87
September 12th	23.17	14.50	8.67
September 21st, mature	25.34	16.04	9.30

Lot cut August 15th ....Other compounds: Nitrogen-free-extract:: 100: 87.3
Lot cut August 28th ....Other compounds: Nitrogen-free-extract:: 100:124.6
Lot cut September 4th ....Other compounds: Nitrogen-free-extract:: 100:148.4
Lot cut September 12th ....Other compounds: Nitrogen-free-extract:: 100:167.2
Lot cut September 21st..... ...Other compounds: Nitrogen-free-extract:: 100:175.4

The answer to our question must be, then, that the changes which are shown in the experiment with Maine field corn to be due to increasing maturity are those which exactly explain the differences between the two varieties of corn compared.

It seems impossible to avoid the conclusion that the inferiority of the larger Southern corn, when compared pound for pound with our smaller Northern variety, is caused in part, at least, by the necessity of harvesting it in an immature condition.

TO THE FORMATION OF WHAT COMPOUNDS IS DUE THE LARGE RELATIVE INCREASE OF NITROGEN-FREE-EXTRACT AS THE CORN PLANT APPROACHES MATURITY.

As before stated an attempt has been made to extend these analyses beyond the usual routine. This has been in the way of determinations of the sugars and starch, in order to learn the extent to which these more valuable carbohydrates are present in the corn plant, and the influence of certain conditions upon their amount.

It is believed that the percentages of starch given in this connection much more nearly represent the actual amounts present in the fodders analyzed than when the ordinary method of analysis is followed.[*]

The method of starch determination generally used is to treat the substance for a given period with hot dilute acid, which results in the conversion not only of starch but partly, at least, of cellulose and gums into glucose. The amount of this sugar is ascertained by its action in precipitating copper oxide from Fehling's solution and all the sugar thus found is assumed to come from starch alone, which is far from the truth. If we did not have reason to believe that starch is greatly superior in food value to the cellulose, gums, etc., which suffer hydrolysis by the action of mineral acids, this assumption would be less fatal to correct conclusions. But so long as starch appears to be entirely digestible, while these other bodies certainly are not, and so long as there is good reason for regarding digested cellulose and gums as less efficient nutrients than digested starch, it is certainly nothing less than absurd to go on assuming that all the sugar produced when vegetable substances are treated with mineral acids comes from starch. The method used here was the conversion of the starch into water-soluble compounds through the action of a ferment known as diastase In the case of a few samples the acid and diastase methods have been compared.

TABLE XIV.

COMPARISON OF PERCENTAGES OF STARCH AS FOUND BY THE ACID AND BY THE DIASTASE METHODS.

	In 100 parts water-free substance.			
	Total nitrogen-free-extract.	Starch, by diastase method.	"Starch," by acid method.	Excess, by acid method.
CLX—Southern Corn, immature, no ears, Field I	50.22	2.03	14.98	12.95
CLXI—Southern Corn, immature, no ears, Field II..	48.96	2.24	15.27	13.03
CLXII—Maine Field Corn, mature, Field I	61.64	18.58	30.32	11.74
CLXIII—Maine Field Corn, mature, Field II..... ...	58.74	12.66	23.97	11.31
CLXX—Southern Corn silage, from CLX........	46.64	3.70	14.63	10.93
CLXXVI—Southern Corn silage, from CLXI...... ...	42.84	3.56	14.90	11.35
CLXXI—Maine Field Corn silage, from CLXII.......	59.31	18.32	29.50	11.18
CLXXIII—Maine Field Corn silage, from CLXIII ...	57.91	17.43	30.00	12.57

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[*] Mr. Bartlett describes his methods on subsequent pages of this report.

The percentages of "starch" by the acid method are greatly but quite uniformly larger than by the diastase method, this excess ranging between 10 93 to 13.03 per cent of the total substance of the plant, or from 24.5 per cent to 31 per cent of the nitrogen-free-extract.

This uniformity of difference in the two methods, while proving nothing, is certainly favorable to confidence in the approximate accuracy of the diastase method, especially where the results range from 2 to 18 per cent. If, for instance, the low percentages of starch in the case of samples CLX. CLXI, CLXX and CLXXVI and the high percentages in the other samples were due to the less perfect extraction of starch in the former, this fact would be disclosed by an increased excess with the acid method. As a matter of fact the acid method shows an excess only .36 per cent larger with the samples low in starch by the diastase methed. Moreover, Mr. Bartlett's report shows that an increase in the time of the action of the diastase beyond a certain limit failed to produce higher results, which makes it improbable that an undissolved residue of starch still existed.

The percentages of sugar and starch in all the samples analyzed in 1892 and 1893 appear in Table XV. In Table XVI are the averages for the immature Southern Corn and the mature Maine Field Corn.

TABLE XV.

PERCENTAGES OF SUGARS AND STARCH IN THE WHOLE CORN PLANT.

Crop of 1892.	Parts in 100 of water-free substance.				Parts of sugar & starch in 100 nitrogen-free-extract.
	Sugar.	Starch.	Total sugar and starch.	Total nitrogen-free-extract.	
Southern Corn, immature .... Field 1..	13.03	2.03	15.06	50.22	30.0
Field 2..	10.60	2.24	12.84	48.96	26.2
Maine Field Corn, mature ....Field 1..	11 88	18.58	30.46	61.46	49.5
Field 2..	11.40	12.66	24.06	58.74	40.9
Southern Corn, silage.......... from Field 1..	-	3.70	3.70	46.64	7.9
Field 2..	-	3.56	3.56	42.84	8.3
Maine Field Corn, silage . .....from Field 1..	-	18.32	18.32	59.31	30.9
Field 2..	-	17.43	17.43	57.91	30.1
Crop of 1893.					
Southern Corn, immature ....Field 1..	13.34	-	13.34	51.10	26.1
Field 2..	14.45	-	14.45	51.94	27.8
Maine Field Corn, mature ....Field 2..	13.50	9.48	22.98	57.81	39.7
Maine Field Corn, very immature, cut Aug. 15th ....Field 1..	11.70	-	11.70	46.60	25.1
Maine Field Corn, cut Aug. 28th .....Field 1..	20.43	2.07	22.50	55.50	40.5
Sept. 4th ......Field 1..	20.60	4.89	25.49	59.74	42.7
Sept. 12th .....Field 1..	21.06	5.35	26.41	62.52	42.2
Maine Field Corn, mature, cut Sept. 21st ....Field 1..	16.50	15.37	31.87	63.30	50.3

TABLE XVI.

COMPARISON OF PERCENTAGES OF SUGARS AND STARCH IN THE DRY SUBSTANCE OF IMMATURE AND MATURE CORN PLANT.

	Parts in 100 of water-free substance.				Parts of sugars and starch in 100 parts of nitrogen-free-extract.
	Sugars.	Starch.	Total sugars and starch.	Total nitrogen-free-extract.	
Southern Corn, immature, no ears, four samples	12.85	1.07	13.92	50.55	27.5
Maine Field Corn, mature, full ears, four samples	13.32	14.02	27.34	60.33	45.3
Excess in the Maine Field Corn	.47	12.95	13.42	9.78	17.8

There is a constant and striking difference between the percentages of starch in the Southern corn and in the Maine field corn. They are much larger in the latter kind. This is due, undoubtedly to greater maturity Only a small amount of starch appears to be deposited in the stalk and leaves, its rapid formation and storage in the plant apparently not beginning until the later development of the fruit or kernels. The analyses of Maine field corn in various stages show this fact very clearly. They also show that while a decrease in sugar occurred with the maturing of the ear, this was much less than the corresponding increase of starch, so that maturity shows a large excess over any other period of the more valuable carbohydrates.

There is, however, over four per cent less of sugar in the mature corn than at any period since the first one investigated. If the influence of maturity is in general to diminish the sugars present, less acidity of the silage would certainly result from the same cause. It appears, however, that there is not less, but rather more, sugar in the mature field corn than in the Southern corn, so that it is reasonable to expect, in these cases at least, fully as acid silage from the former variety.

THE EFFECT OF SLOW DRYING UPON THE COMPOSITION OF A SAMPLE OF A SUCCULENT PLANT.

It must be well known to chemists that in order to secure a sample of a watery plant like green corn, which shall correctly represent its composition, it is necessary that this sample be dried as promptly and as rapidly as possible with a reasonable degree of heat.

One or two experiences at this Station serve, however, to forcibly illustrate this fact.

At the time of cutting the 1893 crop of Maine field corn at different stages of growth it was desired to save some of the first and last cuttings for digestion trials. No means being available for drying the needed quantity by artificial heat, five hundred pounds of each cutting were finely chopped and spread very thinly on a scaffold in the Station barn, over at least six hundred square feet of surface. The doors and windows of the barn were open, which allowed a free circulation of air, and under these conditions the material was allowed to become air-dry. This was accomplished with no apparent moulding or fermentation. Before spreading the last cutting, the chopped material was very thoroughly mixed and a smaller sample of about twenty pounds was selected and taken at once to the Station laboratory, where it was rapidly dried in a steam closet. The following are the analyses of the slowly and rapidly dried samples.

TABLE XVII.

INFLUENCE OF METHOD OF DRYING UPON COMPOSITION OF CORN PLANT.

	In 100 parts fresh corn as cut.								
	Water.	Dry substance.	Ash.	Protein.	Fiber.	Nitrogen-free-extract.	Fat.	Sugars.	Starch.
Rapidly dried sample	74.66	25.34	1.50	2.34	4.71	16.04	.75	4.18	3.89
Slowly dried sample........	78.24	21.76	1.55	2.29	4.67	12.63	.62	1.72	3.66
Difference..............		3.58	.05	.05	.04	3.41	.13	2.46	.23

It seems that for each hundred pounds of green corn 3.58 per cent of dry matter was lost in the process of slow drying under the most favorable circumstances. This was 14.13 per cent of the total dry matter in the fresh plant, which means that of each hundred pounds of dry substance originally in the plant only 85.87 pounds were saved.

It is interesting to note that this loss falls almost entirely on the nitrogen-free extract, or carbohydrates, more than two-thirds of it being actually accounted for by the diminished percentage of sugars.

SUMMARY.

(1) The large varieties of corn which mature in the West and South must be harvested in Maine in a very immature condition, while the smaller Flint varieties may usually be allowed to stand until maturity.

(2) Under these conditions the smaller varieties of Flint corn had, when harvested, a much higher percentage of dry matter than the large immature Dent corn.

(3) The excess of dry matter in the Maine field corn consisted almost wholly of nitrogen-free-extract or the non-nitrogenous part of the plant.

(4) The dry matter of the large immature Dent corn contained .78 per cent more protein, 7.91 per cent more fiber and 9.89 per cent less nitrogen-free-extract.

(5) The development of the Flint corn to maturity caused a large relative production of nitrogen free extract as compared with an earlier stage of growth When in the silking stage the nitrogen-free-extract made up about 47 per cent of the dry matter of the plant, but this proportion increased to 63 per cent at maturity.

(6) The mature corn contained much the larger proportion of the more valuable carbohydrates, the sugars and starch. The starch especially increased, changing in an average of four samples from 1 per cent to 14 per cent of the dry substance of the plant.

(7) It appears from facts previously known, and from observations made in connection with these analyses that the diastase method of determining starch gives more nearly accurate results than the acid method.

(8) A material loss of dry matter is likely to occur when green corn fodder is slowly dried even under the most favorable conditions.

METHODS OF DETERMINING SUGAR AND STARCH.

J. M. Bartlett.

Acid Method. The sugars are determined by the method described in Report Maine Experiment Station, 1888, page 207 and the acid method employed to extract starch was that given on page 208 of same report, except that a one per cent instead of a one-half per cent HCl solution was used.

Diastase Method. Four grams of the finely ground fodder are digested with 50 c. c. water on the steam-bath for one hour, and then 50 c. c. of a freshly prepared extract of malt are added. (The extract is made by placing fifty grams of powdered malt in a liter flask, filling to the mark with distilled water, and then after standing two hours with frequent shaking, the liquid is clarified by passing through a double filter.)

The digestion with the malt is carried on at a temperature of 65° C for four or five hours, which is sufficient time to bring the starch all into a soluble condition, no more being obtained by treating longer. This was shown by several trials. This liquid is then passed through a linen filter and the residue thoroughly washed with warm water, bringing the volume up to about 200 c. c. To complete the conversion of the starch to sugar, 20 c. c. of HCl (Sp. gr. 1.125) are now added and the whole digested on the steam-bath for three hours. After cooling, the liquid is neutralized with caustic potash, then four or five c. c. basic acetate of lead are added, the volume made up to the mark (200 c. c.) and filtered through a dry filter; 25 c. c. are then treated with Fehling solution, in the usual manner. If any lead remains in the solution, it must be removed with sulphurous acid before the Fehling solution is added.

DIGESTION EXPERIMENTS.

W. H. JORDAN.

The digestion experiments reported herewith show the results of three seasons work in that direction. They have been conducted largely as one means of studying the food value of the corn crop for cattle and because of the number of times the observations have been repeated with reasonably uniform results, they furnish to the Maine farmer data that may be considered fairly reliable. It has been deemed better to allow these figures to accumulate until they should constitute a safe basis for general statements, rather than publish them in a disconnected way as obtained. This has been also the more desirable because these trials are chiefly only a part of a general investigation covering several years.

The animals used have in all instances been sheep. The trials have covered a period of twelve or thirteen days, during the last five of which the fæces have been collected. These experiments have been especially free of mishaps, such as refusal to eat the entire ration, impaired health of the animals, or loss of dung from the collecting bags.

It is recognized, of course, that certain conditions operate to limit the accuracy and definiteness of digestion trials, such as individuality of animals, irregularity of excretion, the presence in the fæces of metabolic products which are not properly a part of the undigested food residues, and, in general, the present limitations of analytical methods, which do not admit of a satisfactory study of the digestibility of the various individual compounds of feeding stuffs. The first two conditions are overcome largely by averaging results simultaneously obtained with several animals, and it is hoped that future investigations will remove the difficulties caused by the existing lack of knowledge.

DIGESTIBILITY OF CORN FODDERS.

The various materials coming from the corn plant which have been made the subject of digestion trials not heretofore reported are as follows:

CXLVII. Southern Corn Fodder. Whole plant. Crop of 1891. Cut when the corn was immature, the formation of ears not having begun. Partially air-dried under cover, without showing any mould or decay.

CXLVI. Field Corn Fodder. Whole plant. Crop of 1891. Cut after the ears had become fully developed, the kernels being partially glazed. Partially air-dried under cover, without showing mould or decay.

CXLVIII. Sweet Corn Fodder. Whole plant. Crop of 1891. Cut after the ears had fully developed. Partially air-dried under cover, without showing mould or decay.

CLXX. Southern Corn Silage. Whole plant. Crop of 1892. Cut when immature, the formation of ears having merely begun on some stalks. Chopped and packed in silo. Silage good quality in appearance and flavor.

CLXXI. Field Corn Silage. Whole plant. Crop of 1892. Field No. 1. An abundant crop, heavily eared. Cut after ears had fully developed, the kernels being partially glazed. Chopped for silo. Silage very fine in appearance and flavor.

CLXXIII. Field Corn Silage. Whole plant. Crop of 1892. Field No. 2. A good crop well eared. Cut after the ears had fully developed, the kernels being partially glazed. Silage very fine in appearance and quality.

CCXXVII. Field Corn Fodder. Whole plant. Crop of 1893. Field No. I. Cut August 15th when formation of ears had only fairly begun. Chopped finely, spread very thinly on a scaffold and dried without any apparent fermentation.

CCXXXIII. Field Corn Fodder Whole plant. Crop of 1893. From same field as CCXXVII. Cut September 21st, after ears had fully developed and the the kernels were partially glazed. An abundant crop, heavily eared. Cut fine, spread very thinly on a scaffold and dried with no apparent fermentation.

The composition of the above named materials in the fresh and in the water-free condition is given on previous pages under the head of Analyses of Cattle Foods. Their composition at the time of using them in the digestion trials is stated below.

TABLE XVIII.

COMPOSITION OF FODDER MATERIALS AS FED IN DIGESTION EXPERIMENTS.

	Water.	Ash.	Protein.	Fiber.	Nitrogen-free-extract.	Fat.
CXLVII Southern Corn fodder, partially air-dried	50.50	3.61	6.06	15.87	22.94	1.02
CXLVI Field Corn fodder, partially air-dried	33.24	4.17	8.16	20.40	32.65	1.38
CXLVIII Sweet Corn fodder, partially air-dried	39.30	3.82	8.47	16.85	29.57	2.00
CLXX Southern Corn silage	86.50	1.11	1.69	4.03	6.30	.37
CLXXI Field Corn silage	77.70	1.28	2.25	4.73	13.23	.81
CLXXIII Field Corn silage	79.60	.97	2.09	4.72	11.81	.81
CCXXVII Field Corn fodder, air-dry	17.53	7.69	12.34	21.86	38.44	2.14
CCXXXIII Field Corn fodder, air-dry	18.93	5.79	8.55	17.34	47.08	2.31

The digestion coefficients of the fodders and silages previously described, as determined by actual trials, appear below. The data and necessary calculations can be found on subsequent pages.

TABLE XIX.

DIGESTION COEFFICIENTS OF CORN FODDERS AND CORN SILAGES.

	Dry matter.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free-extract.	Fat.
CXLVII—Southern Corn fodder, 1891	61.3	62.8	43.1	63.4	65.7	61.	59.
CXLVI—Field Corn fodder, 1891	72.7	74.2	50.7	67.6	78.6	73.8	64.7
CXLVIII—Sweet Corn fodder, 1891	70.9	72.7	44.	71.5	74.6	73.1	77.
CLXX—Southern Corn silage, 1892	64.4	65.8	48.2	64.8	66.7	65.4	67.8
CLXXI—Field Corn silage, 1892	78.	80.2	41.3	68.	77.9	83.1	80.9
CLXXIII—Field Corn silage, 1892	76.	77.9	36.6	73.3	77.8	78.5	80.9
CCXXVII—Field Corn fodder, 1893	69.8	71.4	54.5	70.4	72.3	71.3	67.3
CCXXXIII—Field Corn Fodder, 1893	69.7	73.6	20.	68.6	70.7	76.7	73.7

THE DIGESTIBILITY OF CORN FODDER AND CORN SILAGE AS COMPARED WITH OTHER CATTLE FOODS.

During the past four years sixteen different samples of corn fodder and silage have been made the subject of thirty-seven digestion trials at the Maine Experiment Station. These trials have included three varieties of corn both as partially dried fodder and as silage, coming from four years crops excepting in the case of the sweet corn. Further repetition of this work ought not to be necessary in order to establish safe digestion co-efficients for use in Maine feeding practice. The averages of the entire number of trials are for each variety of corn as follows:

TABLE XX.

AVERAGE COEFFICIENTS OF DIGESTIBILITY AS FOUND AT THE MAINE EXPERIMENT STATION.

	Dry matter.	Organic matter.	Ash.	Protein N×6.25.	Fiber.	Nitrogen-free-extract.	Fat.
Southern Corn fodder, 3 samples, 6 trials	65.2	66.8	45.1	62.3	71.5	65.0	66.2
Southern Corn silage, 2 samples, 6 trials	63.8	66.0	31.5	55.7	70.2	65.5	66.5
Field Corn fodder, 4 samples, 9 trials	70.8	73.1	41.9	65.4	76.2	73.3	70.0
Field Corn silage, 3 samples, 8 trials	74.3	76.7	30.0	64.7	76.9	78.3	81.4
Sweet Corn fodder, 3 samples, 6 trials	67.1	69.7	35.6	64.1	73.8	68.2	76.9
Sweet Corn silage, 1 sample, 2 trials	68.1	70.1	31.9	54.0	71.1	71.8	83.5
Timothy hay (average 10 (Maine) samples)	57.0	58.0	37.0	48.0	53.0	63.0	57.0
Wheat bran, average 2 samples	59.0	63.0	-	76.0	-	66.0	73.0
Corn meal*	87.0	-	-	60.0	-	92.0	92.0

* General average.

These figures show beyond question that corn fodder well preserved and corn silage have a high digestibility as compared with hay. To this fact should be attributed in large measure, undoubtedly, the great favor with which the corn plant, as now preserved in the silo, is regarded by dairymen as milk producing food. What has been supposed by many to be due to the peculiar influence of the fermentations in the silo, should more properly be credited to the superior food properties of the plant which the silo conserves so efficiently, and which would be equally valuable when preserved as completely in any other manner.

COMPARATIVE DIGESTIBILITY OF MAINE FIELD CORN AND THE LARGE SOUTHERN WHITE CORN.

There appears to be a marked difference in the digestibility of these two varieties of corn, which were grown under entirely similar conditions as to climate, location and manuring, the former being allowed to mature and the latter cut before silking. The following figures are sufficient evidence of this and show that the advantage is greatly with the smaller variety.

TABLE XXI.

COMPARATIVE DIGESTIBILITY OF TWO VARIETIES OF CORN.

	Dry matter.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extract.	Fat.
Field Corn fodder and silage, 7 samples, 17 trials	72.3	74.6	36.8	65.1	76.5	75.5	74.9
Southern Corn fodder and silage, 5 samples, 12 trials..	64.6	66.5	39.7	59.6	71.0	65.2	66.3
Difference in favor of the Field Corn	7.7	8.1	–	5.5	5.5	10.3	8.6

The observations on which the above comparison is based are too numerous and too nearly a unit in the evidence which they furnish to allow a chance of doubting the significance of the figures. It is certainly a matter of some importance to Maine farmers that the smaller variety of corn, which matures in this latitude, should prove to be more digestible to the extent of about eight per cent of the total dry matter.

The nitrogen-free-extract appears to show a greater difference of digestibility than any other portion of the plant and it is here that we must look for at least a partial explanation of the fact under discussion.

Repeated reference has already been made to the much larger percentage of highly digestible carbohydrates in the mature Maine field corn as compared with the immature Southern corn. This fact must certainly largely account for the superior digestibility of the former. Several examinations of the feces in these experiments have failed to show the presence of sugars or starch, the diastase test being employed for the latter. These carbohydrates being entirely soluble in the digestive fluids, as it was reasonable to expect, their presence in these foods in greatly varying quantities must certainly cause corresponding variations in the digestibility of the nitrogen-free-extract, and consequently of the total dry matter, other things being equal.

That this is so, is easily seen from the figures presented in Table XXII.

TABLE XXII.

DIGESTIBILITY OF NITROGEN-FREE EXTRACT.

	Dry substance fed daily—grams.	In 100 parts dry substance.		Starch and sugars digested daily—grams.	Nitrogen-free-extract, other than starch and sugars digested daily—grams.	Per cent starch and sugars digested.	Per cent nitrogen-free-extract digested, other than starch and sugars.	Per cent total nitrogen-free-extract digested.
		Per cent starch and sugars.	Per cent total nitrogen-free-extract.					
SILAGE.								
CLXX—Southern Corn silage....	337.5	3.70	46.64	12.5	90.4	100.	62.4	65.4
CLXXI—Field Corn silage	437.7	18.32	59.3	80.2	135.6	100.	75.5	83.1
CLXXIII—Field Corn silage......	408.	17.43	57.9	71.1	114.5	100.	69.3	78.5
CORN FODDER.								
CCXXVII—Field Corn, immature, Sheep 1.........	701.	11.70	46.6	82.	155.6	100.	63.6	72.7
CCXXVII—Field Corn, immature, Sheep 3.................. ..	701.	11.70	46.6	82.	150.2	100.	61.4	71.1
CCXXVII—Field Corn, immature, Sheep 4......,............	701.	11.70	46.6	82.	147.7	100.	60.4	70.3
CCXXXIII—Field Corn, mature, Sheep 1	689.	31.87	63.3	219.6	92.2	100.	51.	77.9
CCXXXIII—Field Corn, mature, Sheep 3	689.	31.87	63.3	219.6	80.7	100.	44.7	75.5
CCXXXIII—Field Corn, mature, Sheep 4	689.	31.87	63.3	219.6	88.	100.	48.7	76.7

THE DIGESTIBILITY OF THE PENTOSE CARBOHYDRATES.[*]

W. E. STONE AND W. J. JONES.

[†]During the past five years attention has frequently been called to the occurrence, in many vegetable materials, of the pentosans, the term being applied to those carbohydrate-like bodies, which, upon hydrolysis produce the pentatomic sugars, arabinose or xylose, as the case may be. The presence of pentosans may be recognized by heating the materials with moderately concentrated hydrochloric or sulphuric acid, when furfurol is formed and may be detected in the vapors by the intense red color produced upon test paper freshly moistened with anilin acetate. This reaction is very sensitive and may be obtained, almost without exception, from all vegetable substances. So far as is at present known furfurol is, under these conditions, produced only from the pentose carbohydrates, with the exception of the rare glucuronic acid and its derivatives. The above mentioned test has therefore come to be regarded as a specific one, and its wide application seems to justify the statement that the pentosans are common constituents of vegetable substances. Upon closer examination it has also been found that many food materials contain the pentosans in very appreciable quantities, and it becomes desirable therefore to know something of their food value and digestibility. The ordinary food analysis, however, quite ignores these bodies except to classify them indiscriminately with all the other soluble non-nitrogenous compounds under the general term "nitrogen-free-extract matter." It is only within a short time, that any analytical method has existed which permits a separate estimation of these bodies. Such methods are now known in two or three modifications, any of which are capable of showing conclusively and with considerable accuracy, the presence of the pentosans under all conditions. It has therefore become possible to

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[*] This article is extracted from Agricultural Science Vol. VII, No. 1, p. 6.

[†] These extracts are reprinted in this connection partly because of the importance of the results and partly to give added prominence and emphasis to investigation of this sort. Our knowledge of the constitution and properties of many food compounds is sadly deficient, and the most pressing need of to-day in the line of animal nutrition is work of the kind which Dr. Stone and his associates have done in studying the carbohydrate group. Investigations of this class will be potent in shaping future knowledge and will be quoted long after many of the so called practical experiments are buried in a heap of rubbish. W. H. J.

obtain some idea as to the digestibility of these bodies by including these methods among the analytical processes controlling an ordinary digestion experiment.

One of us has already published the results of a brief digestion experiment with rabbits, from which it appeared that in a normal ration about sixty per cent. of the pentosans were digested It was also noticed that the proportion of pentosans to the entire amount of nitrogen-free-extract was much increased in the fæces as compared with the food. These results, however, being based upon meagre data, had little more than a suggestive value, as showing the importance of further study in the same direction. The present paper adds a considerable amount of proof to the previous one without materially changing the conclusions then drawn.

Some months since, Professor W. H. Jordan, Director of the Maine Experiment Station, placed at our disposal a large number of control samples of the food and fæces from digestion experiments, carried on by him during a series of years. These samples had been carefully preserved in air-tight vessels and reached us in excellent condition. We have determined the pentosans in these samples and from the feeding data furnished us by Professor Jordan, we are enabled to report upon their digestibility in twenty different experiments. . . . . The errors . . . . . of the analytical methods and of the assumption upon which the calculations are based, are all such as to minimize the actual results. In the same direction, we have presented here the lowest results obtained from duplicate determinations in each case. The data, here given indicate, therefore, the minimum amounts of pentosans found, so that the results of future study and perfected methods will, we believe, emphasize rather than diminish the conclusions here drawn.

The materials used in the digestion experiments were in part, selected samples of single species of grasses grown for the purpose at the Maine Experiment Station, and the samples were typical of our forage grasses. It is of preliminary interest, therefore, to mark the extent to which the pentosans occur in these and other materials of common and frequent use as cattle foods.

The furfurol (i. e. pentosans) was determined in each sample in duplicate by separate distillations. The lowest of these results was then multiplied by the factor 1.38 to convert it into a value representing pentosans. For comparison, the percentages of nitrogen-free-extract matter as given in Professor Jordan's report, are repeated here. All numbers relate to the dry matter.

	Per ct. furfural.		Per cent pentosans (a×1.38).	Per cent N-free-extract.
	a.	b.		
LXXXVI Phlemn pratense, in early bloom	11.34	11.45	15.65	51.94
LXXXVII Phlemn pratense, 10 days after bloom	11.72	11.83	16.17	55.51
CXIX Phlemn pratense, early cut	9.79	9.85	12.59	46.50
CXX Phlemn pratense, late cut	10.34	10.91	14.26	51.11
CXL Timothy hay; chiefly Phlemn pratense	8.33	8.48	11.50	50.17
CLXI Same; another selection	8.88	8.94	12.25	50.16
LXXXVIII Danthonia Spicata	8.87	9.63	12.24	52.07
LXXXIX Argrostis Vulgaris	9.62	9.62	13.27	53.43
XCVI Calamagrostis Canadensis, in bloom	7.83	8.06	10.81	45.25
XCVII Triticum repens	8.39	8.72	11.58	52.94
CXXVIII Hay of Hungarian grass	9.93	10.23	13.70	47.52
XC Trifolium hybridum	6.41	7.90	8.85	44.39
CXXV Field Corn fodder	11.93	12.05	16.46	52.45
LXXXIII Southern Corn fodder	8.35	8.57	11.52	46.09
CXXXIII Sugar beets	7.48	8.16	10.32	77.31
CXXX Rutabagas	5.99	6.11	8.26	71.29
CXXXIV Gluten meal	4.46	4.70	6.15	52.60
XCII Fancy middlings	6.79	7.02	9.37	64.18
XCI Wheat bran	8.68	9.15	11.88	60.28
CXXXV Wheat bran, another selection	11.56	11.63	15.95	58.93

These results are quite confirmatory of those previously given, showing the presence of appreciable amounts of these bodies in all of these common food materials. The grasses make the largest showing, but in the majority of samples the pentosans amounted to from twenty to thirty per cent of the non-nitrogenous extractive matter.

Accompany the above samples were corresponding samples of the fæces of the animals employed in the digestion experiments, duplicated in each case. We have determined the amount of pentosans in each of these and from the gross weights of the food consumed and fæces excreted have calculated in the usual way the digestibility of the pentosans in question. These digestion experiments were conducted under the usual precautions and control, all of which, together with the analytical data, have been published in Professor Jordan's reports. The animals experimented upon were sheep in each case. . . . . . Summarizing the results of the preceding experiments, we have the following oversight of the twenty materials studied:

	Per cent of pentosans digested.
LXXXVI Phleum pratense, early bloom	60.4
LXXXVII Phleum pratense, late cut	62.8
CXIX Phleum pratense, early bloom	54 6
CXX Phleum pratense, late cut	48.2
CXL Timothy hay (chiefly Phleum pratense)	48.0
CXLI Timothy hay (chiefly Phleum pratense	49.5
LXXXVIII Danthonia spicata	68.6
LXXXIX Agrostis vulgaris	70.0
XCVI Calamagrostis Canadensis	90.4
XCVII Triticum repens	59.9
CXXVIII Hungarian grass	68.2
XC Trifolium hybridum	56.8
CXXV Fodder of field corn	76.6
LXXXIII Fodder of Southern field corn	69.6
Timothy hay, CXL, and sugar beets	71.3
Timothy hay, CXL, rutabagas	57.1
Timothy hay, CXLI, and wheat bran	45 6
Timothy hay, CXLI, gluten meal	59.1
Hay of Agrostis vulgaris, LXXXIX, and wheat bran,	54 1
Hay of Agrostis vulgaris, LXXXIX, wheat middlings,	64.9

The average of these various results, excluding the data for Calamagrostis Canadensis, which evidently present something anomalous, shows 58.2 per cent of pentosans to have been digested and 41.8 per cent undigested.

These results are worthy of consideration. Twenty of the best known food stuffs for cattle are here shown to contain a minimum of from 6-16 per cent of their dry weight in pentosans, of which an average of only 58.2 per cent is found to be digestible. It appears then, that while these bodies are to be for the present classified among the carbohydrates, they are really much less digestible, and hence of less food value, than the better known members of this group, such as starch, sugar, etc. In many cases the indicated digestibility is even less than that assigned to the fibre of the same materials and the average of all the experiments is but little higher than the corresponding average for the fibre. Indeed from the data at hand it would appear that of all the food constituents capable of individual estimation, these are among the less soluble in the digestive fluids, although commonly included among those substances which are regarded as in a high degree digestible.

Not only do the pentosans seem to be of low digestibility, but according to Ebstein, the pentoses derived from them by hydrolysis (arabinose and xylose) are little, if at all assimilated, although readily soluble. He has lately shown that the pentose sugars even in very small quantities are not assimilated by the human organism. Xylose taken in doses of less than one dram by healthy persons, could be recognized in the urine after two or three hours, and hence the use of these sugars even by healthy and much more by diabetic persons could yield no beneficial results. In this connection it is of interest to remember that the pentoses are also non-fermentable. As regards their physiological behavior, they are evidently quite distinct from the hexoses, although otherwise resembling them in chemical characteristics. It is not surprising, therefore, that the less soluble mother substance the pentosans, should also prove less digestible than other carbohydrates. In the light of Ebstein's observations, there is, moreover, good reason for believing that even such portions of the pentosans as are dissolved in the digestive tract are, after all, not assimilated.

Chemical Laboratory, Purdue University, November, 1892.

SUMMARY.

(1) A study of the digestibility of the whole corn plant shows it to have a high percentage digestibility as compared with hays and other coarse fodders, especially when allowed to develop to maturity. Of ten samples of Timothy hay, 57 per cent of the dry matter has proved to be digestible, while of Flint corn fodder (whole plant, mature) 71 per cent was digested.

(2) The mature Flint corn has proved to be more digestible than the immature Dent corn, the relation for all trials of fodder and silage being as 72 : 65.

(3) This large difference of digestibility of the two varieties of corn as harvested in Maine is undoubtedly due to the greater proportion of fiber in the Dent corn and to the larger relative amount of entirely digestible sugars and starch in mature Flint corn. This

is shown in part by the fact the excess of digestibility of the latter variety falls largely upon the nitrogen-free extract.

(4) Dr. Stone's investigations of samples of foods and fæces from digestion experiments conducted at this Station show that the pentosans (vegetable gums) were present in all the foods studied, and were digested from 45 per cent to 76 per cent. Dr. Stone observes that there is good reason for believing that even such portions of the pentosans as are dissolved in the digestive tract are, after all, not assimilated.

DATA PERTAINING TO DIGESTION EXPERIMENTS.

TABLE XXII *a*.

COMPOSITION OF THE FECES.

	In 100 parts of dry matter.				
	Ash.	Protein. Nx6.25.	Fiber.	Nitrogen-free-extract.	Fat.
CXLVII—Southern Corn fodder, Sheep 1.... ..	10.56	11.32	27.84	48.04	2.24
Sheep 3.......	11.45	13.46	25.45	47.30	2.35
CXLVI—Field Corn fodder, Sheep 1.....	11.38	14.69	23.43	47.34	3.14
Sheep 3...........	11.16	15.89	22.01	48.41	2.53
CXLVIII—Sweet Corn fodder, Sheep 2.........	11.98	14.06	23.70	47.34	2.92
Sheep 4.........	11.54	14.27	23.02	48.55	2.62
CLXX—Southern Corn silage, Sheep 1, 2, 3, 4...	11.93	12.35	27.84	45.37	2.51
CLXXI—Field Corn silage, Sheep 1, 2, 3, 4......	15.33	14.67	21.30	45.53	3.17
CLXXIII—Field Corn silage, Sheep 1, 3.......	12.48	11.34	21.40	51.62	3.16
CLXXIV—Barley Hay, Sheep 1, 2, 3, 4...........	10.25	11.72	29.68	43.90	4.45
CCXXXIII—Field Corn fodder, Sheep 1.........	18.55	12.80	21.77	44.60	2.28
Sheep 3........	19.43	12.92	20.56	44.46	2.63
Sheep 4........	18.62	14.15	19.84	44.88	2.51
CCXXVII—Field Corn fodder, Sheep 1...... ...	13.15	14.32	24.91	44.91	2.71
Sheep 3..........	15.45	14.87	23.82	42.78	3.08
Sheep 4.....	13.57	14.65	24.21	44.83	2.74

CALCULATIONS OF DIGESTION CO-EFFICIENTS.

TABLE XXIII.

DIGESTIBILITY OF SOUTHERN CORN FODDER.

SHEEP 1.	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free-extract.	Fats.
Southern Corn fodder, CXLVII.							
1,500 grams air-dry fodder daily.....	739.5	685.1	54.05	90.57	237.0	342.6	15.2
Not eaten..............................	139.5	131.4	8.3	10.80	61.8	56.7	2.0
Amount eaten daily..................	600.0	553.7	45.7	79.77	175.2	285.9	13.2
Excreted in fæces daily.............	231.8	207.2	24.5	26.2	64.5	111.3	5.2
	368.2	346.5	21.2	53.57	110.7	174.6	8.0
Digested, per cent....................	61.2	62.6	46.2	67.2	63.2	61.1	60.6
SHEEP 3.							
1,500 grams air-dry fodder fed daily.	739.5	685.1	54.0	90.6	237.0	342.6	15.2
Not eaten..............................	65.9	61.6	4.3	4.8	28.6	27.4	.8
Amount eaten daily..................	673.6	623.5	49.7	85.8	208.4	315.2	14.4
Excreted in fæces daily.............	259.8	230.0	29.7	34.6	66.2	122.9	6.1
Digested..............................	413.8	393.5	20.0	51.2	142.2	192.3	8.3
Digested, per cent....................	61.4	63.1	40.2	59.7	68.2	61.0	57.7
Average..................................	61.3	62.8	43.1	63.4	65.7	61.0	59.0

TABLE XXIV.

DIGESTIBILITY OF FIELD CORN FODDER.

SHEEP 1.	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free extractive matter.	Fat.
Field Corn Fodder, CXLVI.							
1,500 grams air-dry fodder daily	1,003.5	940.4	62.6	122.6	306.6	491.0	20.3
Not eaten	153.3	143.8	9.7	12.5	60.5	68.3	2.3
Amount eaten daily	850.2	796.6	52.9	110.1	246.1	422.7	18.0
Excreted in feces daily	232.8	206.2	26.5	34.2	54.6	110.2	7.3
Digested	617.4	590.4	26.4	75.9	191.5	312.5	10.7
Digested, per cent	72.6	74.1	50.0	68.9	77.8	73.9	59.4
SHEEP 3.							
1,500 grams air-dry fodder fed daily.	1,003.5	940.4	62.6	122.6	306.6	491.0	20.3
Not eaten...........	160.1	149.5	10.5	14.8	61.1	71.3	2.4
Amount eaten daily	843.4	790.9	52.1	107.8	245.5	419.7	17.9
Excreted in feces daily................	228.2	202.8	25.3	36.2	50.3	110.5	5.8
Digested	615.2	588.1	26.8	71.6	195.2	309.2	12.1
Digested, per cent	72.9	74.3	51.4	66.4	79.5	73.7	70.0
Average	72.7	74.2	50.7	67.6	78.6	73.8	64.7

TABLE XXV.

DIGESTIBILITY OF SWEET CORN FODDER.

SHEEP 2.	Dry substance.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free-extract.	Fat.
Sweet Corn Fodder, CXLVIII.							
1,500 grams air-dry fodder daily	907.5	850.2	57.1	126.7	251.7	442.1	29.8
Not eaten	111.1	101.9	9.2	9.6	42.4	48.4	1.6
Amount eaten daily..............	796.4	748.3	47.9	117.1	209.3	393.7	28.2
Excreted in feces daily	248.0	218.2	29.7	34.9	58.8	107.1	7.2
Digested	548.4	530.1	18.2	82.2	150.5	186.6	21.0
Digested, per cent....................	68.8	70.8	38.0	70.2	71.9	72.8	74.5
SHEEP 4.							
1,500 grams air-dry fodder daily	907.5	850.2	57.1	126.7	251.7	442.1	29.8
Not eaten	46.3	42.1	4.1	4.6	18.2	18.9	.6
Amount eaten daily	861.2	808.1	53.0	122.1	233.5	423.2	29.2
Excreted in feces daily	231.8	205.0	26.8	33.1	53.3	112.5	6.0
Digested	629.4	603.1	26.2	89.0	180.2	310.7	23.2
Digested, per cent	73.1	74.6	50.0	72.8	77.3	73.4	79.6
Average	70.9	72.7	44.0	71.5	74.6	73.1	77.0

TABLE XXVI.

DIGESTIBILITY OF SOUTHERN CORN SILAGE.

	Dry matter.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free-extract.	Fat.
Southern Corn Silage, CLXX.							
2,500 grams silage daily...	337.5	309.7	27.7	42.2	100.7	157.4	9.4
Excreted daily	120.3	105.9	14.3	14.8	33.5	54.5	3.0
Amount digested..	217.2	203.8	13.4	274.0	67.2	102.9	6.4
Per cent digested	64.4	65.8	48.2	64.8	66.7	65.4	67.8

DIGESTIBILITY OF FIELD CORN SILAGE.

	Dry matter.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free-extract.	Fat.
Field Corn Silage, CLXXI.							
19,630 grams silage daily..............	437.7	412.6	25.1	44.2	92.8	259.6	15.9
Excreted daily..........................	96.2	81.4	14.7	14.1	20.5	43.8	3.0
Amount digested	341.5	331.2	10.4	30.1	72.3	215.8	12.9
Per cent digested	78.0	80.2	41.3	68.1	77.9	83.1	80.9

TABLE XXVII.

DIGESTIBILITY OF FIELD CORN SILAGE.

	Dry matter.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free-extract.	Fat.
Field Corn Silage, CLXXIII.							
2,000 grams fed daily	408.0	388.7	19.3	41.7	94.4	236.3	16.3
Excreted daily	98.2	85.9	12.3	11.1	21.0	50.7	3.1
Digested	309.8	302.8	7.0	30.6	73.4	185.6	13.2
Per cent, digested	76.0	77.9	36.6	73.3	77.8	78.5	80.9

DIGESTIBILITY OF BARLEY HAY.

Barley Hay, CLXXIV.							
675 grams fed daily	576.2	534.7	41.5	77.1	173.7	267.1	16.6
Not eaten	19.0	17.8	1.2	2.4	5.7	9.2	.4
Consumed daily	557.2	516.9	40.3	74.7	168.0	257.9	16.2
Excreted daily	216.7	194.5	22.2	25.4	64.3	95.1	9.6
Digested	340.5	322.4	18.1	49.3	103.7	162.8	6.6
Per cent, digested	59.1	62.3	44.8	65.2	61.7	63.3	40.5

TABLE XXVIII.

DIGESTIBILITY OF FIELD CORN FODDER (MATURE).

SHEEP 1.	Dry matter.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free-extract.	Fat.
Field Corn Fodder, CCXXXIII.							
850 grams fed daily	689.0	639.8	49.2	72.7	147.4	400.2	19.6
Excreted daily	198.3	161.5	36.8	25.4	43.2	88.4	4.5
Digested	490.7	478.3	12.4	47.3	104.2	311.8	15.1
Per cent digested	71.2	74.8	25.2	65.1	70.7	77.9	77.0
SHEEP 3.							
850 grams fed daily	689.0	639.8	49.2	72.7	147.4	400.2	19.6
Excreted daily	220.0	177.4	42.8	28.4	45.3	99.9	5.8
Digested	468.8	462.4	6.4	44.3	102.1	300.3	13.8
Per cent digested	68.1	72.3	13.0	60.9	69.3	75.5	70.5
SHEEP 4.							
850 grams fed daily	689.0	639.8	49.2	72.7	147.4	400.2	19.6
Excreted daily	206.5	168.0	38.4	29.2	40.9	92.6	5.2
Digested	482.5	471.8	10.8	43.5	106.5	307.6	14.4
Per cent digested	70.0	73.8	21.9	59.8	72.2	76.9	73.6
Average	69.7	73.6	20.0	68.6	70.7	76.7	73.7

TABLE XXIX.

DIGESTIBILITY OF FIELD CORN FODDER (IMMATURE).

SHEEP 1.	Dry matter.	Organic matter.	Ash.	Protein.	Fiber.	Nitrogen-free-extract.	Fat.
Field Corn Fodder, CCXXVII.							
850 grams fed daily	701.0	635.6	65.4	104.9	185.8	326.6	18.3
Excreted daily	198.0	172.0	26.0	28.3	49.3	69.0	5.3
Digested	503.0	463.6	39.4	76.6	136.5	257.6	13.0
Per cent digested	71.7	72.9	60.2	72.9	73.4	72.7	70.6
SHEEP 3.							
850 grams fed daily	701.0	635.6	65.4	104.9	185.8	326.6	18.3
Excreted daily	220.6	186.6	34.1	32.8	52.5	94.4	6.8
Digested	480.4	449.0	31.3	72.1	133.3	232.2	11.5
Per cent digested	68.6	70.7	48.1	68.7	71.7	71.1	62.9
SHEEP 4.							
850 grams fed daily	701.0	635.6	65.4	104.9	185.8	326.6	18.3
Excreted daily	216.0	186.8	29.3	31.6	52.3	96.9	5.7
Digested	485.0	448.8	36.1	73.3	133.5	229.7	12.6
Per cent digested	69.2	70.6	55.2	69.8	71.8	70.3	68.4
Average per cent digested	69.8	71.4	54.5	70.4	72.3	71.3	67.3

CORN AS A SILAGE CROP.

W. H. JORDAN.

The report of the Station for 1891, pp. 41-46 gives a summary of three years work in testing the relative production of food material by various fodder and root crops. It appeared that the large variety of corn known as Southern White produced the greatest amount of digestible dry substance per acre, excelling root crops, Hungarian grass and other varieties of corn. Since 1891 a comparison between varieties of corn has been continued. This has been done because this crop is an important one to Maine dairymen and because the problems connected with its growth in Maine are local in their nature and cannot be solved by experiments in other states, excepting possibly, New Hampshire and Vermont.

The most common question asked in this connection is, Which are the most profitable varieties to grow, the large, which mature only in a latitude south of New England or the smaller which complete their growth in this climate?

As set forth in the report previously mentioned, the proper test of productiveness is the yield of digestible dry matter, the gross weight of crop or even of total dry matter being deceptive because of differences on the water content and in the digestibility. All effort has been directed, then, towards ascertaining the actual growth of digestible material in the several cases. One other point has necessarily been considered, viz: the relative value of a pound of digestible material in the crops compared. This latter comparison can most safely be made by a feeding experiment and this has been the method used. The study of the corn crop has been conducted in 1892 and 1893 in much the same manner as in previous years only somewhat more comprehensively.

The data recorded in succeeding pages have been obtained,

(1) By weighing the green crop as harvested.

(2) By immediate drying of the green product to ascertain the dry matter.

(3) By analysis of the dry matter to determine its composition.

(4) By a partial chemical study of the nitrogen-free-extract.

(5) Digestion experiments with sheep.

All this work centers around two problems: First, the relative yield of digestible dry matter in immature Southern Dent corn and in mature Maine field corn; and second, the influence of maturity on the amount and kind of product.

Weight of Green Product. This was ascertained by cutting the whole field, and hauling to the barn and weighing as fast as cut.

Determination of Dry Matter. Several hundred pounds carefully selected from the several rows of each plot were cut by the horse power fodder cutter, thoroughly mixed, from which a large sample was taken for drying in a steam closet.

Chemical Analysis. These results have been described in previous pages. The ordinary analysis was by the methods of the A. O. A. C.

Digestion Experiments. These trials have been carried on either with the partially dried fodder or with the silage made from it. The detailed results of these experiments have been previously given.

Manuring and Method of Planting. 1892. Field No. 1. Size one acre, soil, a loam, somewhat lighter than clayey loam, shading towards sandy. Summer fallowed in 1891 to kill witch grass. About six cords of stable manure and a fertilizer consisting of four hundred pounds dissolved bone black, one hundred pounds muriate of potash, and seventy-five pounds nitrate of soda, applied in spring. Planted in rows three and one-half feet apart, with kernels six inches apart in drills. Level, clean culture. Planted May 19th, harvested September 6th to 9th.

Field No. 2. Size, one acre, soil, clayey loam. Planted to corn in 1891. About seven cords of stable manure and the same amount and kind of fertilizer as on Field No. 1, applied in spring. Culture and planting same as Field No. 1. Planted May 19th, harvested September 6th-9th.

1893. Field No. 1, same as in 1892. About six cords of stable manure and five hundred pounds of Bay State fertilizer, applied in spring. Planting and culture as 1892. Planted May 31st, harvested September 14th to 16th.

Field No. 2, same as in 1892. Manuring, planting and culture same as Field No. 1. Planted May 31st, harvested September 14th to 16th.

In both fields. during both years, each acre was divided into twenty plots, the two kinds of corn alternating, ten plots being devoted to each. It is scarcely possible to secure conditions more uniform in which to compare the growth of two crops than existed in these experiments.

The results secured are concisely stated in Table XXX, all intermediate data such as size of plots and yield per plot, being omitted. The figures for the three years previous are stated for the sake of comparison

TABLE XXX.

COMPARATIVE YIELD OF SOUTHERN CORN AND MAINE FIELD CORN, AS GROWN IN MAINE—YIELD PER ACRE.

	Green corn, (whole plant)—pounds.	Dry substance.		Digestible dry substance.	
		Per cent.	Pounds.	Per cent.	Pounds.
Crop of 1888.					
Southern Corn	26,295	12.30	3,234.3	65	2,102.3
Maine Field Corn	14,212	17.4	2,472.9	70	1,720.5
Crop of 1890.					
Southern Corn	32,950	14.94	4,922.7	69	3,396.7
Maine Field Corn	15,300	15.84	2,415.9	71	1,715.3
Crop of 1891.					
Southern Corn	46,340	13.46	6,237.4	61	3,804.8
Maine Field Corn	28,080	13.55	3,804.8	73	2,777.5
Crop of 1892.					
Southern Corn, Field 1	37,320	14.67	5,474.8	64	3,503.9
Field 2	34,820	14.15	4,927.0	64	3,153.2
Maine Field Corn, Field 1	22,490	20.90	4,700.0	78	3,666.0
Field 2	29,400	18.64	5,480.0	76	4,164.8
Crop of 1893.					
Southern Corn, Field 1	39,066	15.45	6,036.7	* 65	3,923.2
Field 2	26,660	16.58	4,420.2	* 65	2,873.1
Maine Field Corn, Field 1	27,780	25.43	7,064.4	70	4,945.0
Field 2	18,610	19.50	3,628.9	70	2,540.2
Southern Corn, 7 trials.					
Maximum	46,340	16.58	6,237.4	69	3,923.2
Minimum	26,295	12.30	3,234.3	61	2,102.3
Average	34,761	14.50	5,036.0	65	3,251.0
Maine Field Corn, 7 trials.					
Maximum	29,400	25.43	7,064.4	78	4,945.0
Minimum	14,212	13.55	2,415.2	70	1,715.3
Average	22,269	18.75	4,224.0	73	3,076.0

* The average of previous years.

The foregoing figures show a large variation in production in different years, under conditions other than the season, quite uniform. This variation is not alone in gross weight of crop, but in dry matter as well The largest quantity of dry matter produced in any case during five years is nearly three times that yielded by the smallest crop. This is due in part to the manuring and cultivation and in part to the character of the season.

Had these experiments been discontinued after 1891 the outcome would have been decidedly favorable to the large variety of Dent corn. but in 1892 and 1893, the relation of yield has been reversed and the smaller variety of Flint corn has taken the lead. It is probable that another five years' series of comparisons would furnish a somewhat similar experience.

The general outcome for the five years is slightly favorable to the large variety of corn if we consider only the yield of digestible dry matter. But when we take account of the fact that in the one case an average of five and one-half tons more of material have annually been handled over several times, we are led to conclude that the smaller, less watery variety of corn has really proved the more profitable.

It is significant, also, that the largest yield of dry matter in any instance has been from the smaller variety. While the Flint corn grown in this State is not capable of producing so much dry substance as the large variety of Dent corn, under circumstances equally favorable for both, the former cannot in this latitude reach anything like maturity, and so loses the advantage of that period when growth is most rapid, as subsequent figures show.

The writer has made one or two observations during these five years which may be worth noting. One is that the cut worm scarcely ever molests the large Dent corn, even when feeding freely on the smaller Flint variety. This fact was observed during two years. It is also the writer's opinion, from observation, that conditions unfavorable as to fertility and cultivation will reduce the growth of the Maine corn to the greater extent.

A condensed summary of the results which are the outcome of this series of experiments, appears below. These statements stand somewhat in conflict with those of the 1891 report. It must be remembered, however, that the honest experimenter is limited in his conclusions to the facts which appear after a careful analysis of data. Facts should always outweigh existing opinions. Such a rule of action often requires a reversal of former conclusions. This experience may be unfortunate but is not blameworthy.

(1) The average weight per acre of the green crops for five years were: Southern corn, 34,761 pounds; Maine field corn, 22,269 pounds; difference, 11,492 pounds, or nearly five and three-fourths tons.

(2) The average dry matter per hundred pounds was nearly one-third more in the Maine field corn, the relation being: Southern corn 14.50 pounds; Maine field corn 18.75 pounds, or as 100:129.

(3) The Maine field corn proved to be more digestible, the relation for dry matter being: Southern corn, 65; Maine corn, 73, or as 100:112.

(4) The average pounds of digestible dry matter per hundred pounds of green corn have been: Southern corn 7.25 pounds; Maine field corn 13.69 pounds, or as 100:189.

(5) The average yield of dry matter per acre has been: Southern corn 5,036 pounds,—extremes, 7,064 pounds and 2,415 pounds.

(6) The average yield of *digestible* dry matter has been: Southern corn 3,251 pounds,—extremes 3,923 pounds and 2,102 pounds; Maine field corn 3,076 pounds,—extremes 4,945 pounds and 1,715 pounds.

(7) The yield of digestible dry matter has averaged 175 pounds more per acre with the Southern corn. To offset this it has been necessary to handle annually five and three-fourths tons more weight.

(8) The largest as well as the smallest yield of digestible dry matter in a single year has been furnished by the Maine field corn.

THE INFLUENCE OF MATURITY UPON THE VALUE OF THE CORN CROP FOR FODDER OR SILAGE PURPOSES.

There have existed, without doubt, some very erroneous notions in regard to the relative value of the corn crop at different stages of growth. Corn that is thickly planted and cut when quite immature is so easily masticated and is eaten with such evident relish, that such material has by many been regarded more highly than the facts warrant. Correct views prevail to a greater extent than formerly, partly because several careful experiments, the results of which have been widely published, show that the plant continues to increase its store of dry substance until full maturity and that this growth is very rapid during the last stages of development.

It was understood, therefore, that an experiment along this line would be to an extent a repetition. Nevertheless for several reasons it was thought best to do this. In the first place an unusually good opportunity was offered to secure uniform conditions as to soil. Again, the outcome whatever it might be would be a more valuable object lesson to Maine farmers than results reached in some other state. Finally, it was desired to learn something as to the nature of the growth which is so rapid at approaching maturity.

The field of corn selected for studying the influence of maturity was the one designated as Field No. 1 (1893). The corn was of very uniform growth, being finely eared and in every way satisfactory for experimental purposes.

Each of the ten plots consisted of five rows, and it was decided to harvest one-fifth of the crop or one-tenth of an acre at each of five periods of growth, cutting one row of each plot at each period. As in other similar experiments, quite an amount of each lot was finely chopped, and a portion of this was immediately dried in a steam closet.

TABLE XXXI.

PRODUCTION OF THE CORN PLANT AT DIFFERENT STAGES OF GROWTH.

Date of cutting and condition of crop.	Days in each period of growth.	Yield of green corn per acre.	Dry substance.		Gain in weight in e'ch period, dry matter—lbs.	Rate of gain per day—dry matter—lbs.
			Per cent in crop.	Total yield per acre—lbs.		
August 15th, ears beginning to form		26,166	11.71	3,064.0		
August 28th, a few roasting ears....	13	29,777	17.50	5,210.9	2,146.9	165.0
Sept. 4th, all roasting ears...........	7	31,000	19.55	6,060.5	849.6	121.3
Sept. 12th, some ears glazing.......	8	28,833	23.17	6,680.6	620.1	77.5
Sept. 21st, All ears glazed............	9	27,777	25.34	7,039.7	358.1	39.8
Total increase after August 15th	-	-	-	-	3,974.7	

The results of this experiment certainly furnish a striking illustration of the folly of harvesting immature corn for silage purposes whenever it is possible to allow it to attain maturity.

In this instance, the quantity of dry matter in the corn at maturity was nearly two and one-half times greater than at the silking period thirty-seven days previous, the average rate of increase per acre of dry substance being about 108 pounds daily. This daily increase is equivalent in quantity to one day's ration for four or five cows of ordinary weight.

The character of this growth has been clearly set forth on previous pages, in discussing the analyses of these samples of corn fodder. The facts that appear can be emphasized, however, by a display of the quantities of the different classes of nutrients found to exist at the different periods of growth.

The figures in Table XXXII are the results of applying the foregoing analyses to the total yield of dry matter

TABLE XXXII.

PRODUCTION OF DIFFERENT CLASSES OF COMPOUNDS BY THE CORN PLANT AT DIFFERENT STAGES OF GROWTH.

	Ash.	Protein, Nx6.25.	Fiber.	Nitrogen-free-extract.	Sugars.	Starch.	Fat.
August 15th, ears beginning to form*	285.9	458.4	812.3	1,428	358.5	–	79.7
August 28th, a few roasting ears	338.7	611.7	1,214.0	2,892	1,064.0	108	153.7
September 4th, all roasting stage....	376.3	689.6	1,192.0	3,621	1,248.0	297	181.8
September 12th, some ears glazing..	372.4	639.5	1,291.0	4,177	1,407.0	357	200.4
September 21st, all ears glazed......	416.1	649.8	1,369.0	4,457	1,161.0	1,083	208.4
Gain after August 15th...............	130.2	191.4	496.7	3,029	802.5	1,083	128.7
Gain after August 28th...............	77.4	38.1	95.0	1,565	97.0	975	54.7

*The manner of drying the sample taken from the lot cut at this period may have caused a loss of sugar.

From August 15th to August 28th there appears to have been considerable growth of the compounds of all classes, but after that date the increase of dry matter was due chiefly to the formation of one class of compounds. After August 28th, and until September 21st, the total growth was 1,828 pounds of dry matter, 1,565 pounds of which, or all but 263 pounds, belonged to the nitrogen-free-extract. Of this 1,565 pounds, 1,072 pounds consisted of sugars and starch. Two facts are clearly shown: First, that the later growth of dry matter in the corn plant is made up chiefly of non-nitrogenous compounds; and second, a large percentage of these compounds consisted of sugars and starch, substances that are the best of their class for the purposes of animal nutrition.

Feeding Experiments.

W H. JORDAN.

There are two methods of judging the value of cattle foods. In common parlance one would be styled "scientific" and the other "practical." Both may be correctly classed as scientific or as practical according to the manner in which they are carried out and the standpoint from which they are regarded. Certainly if a conclusion is reached through truly scientific means it must have an entirely practical application, and no conclusion can be safely applied to the management of a business, which has not been reached in a way that is essentially scientific.

The two methods by which we may study a cattle food in trying to estimate its value, are: First, determine its composition and digestibility and then from known principles and the facts determined derive an opinion as to the place this food will take in stock feeding; and second, to feed this food to a given class of animals, under conditions as definite and as well controlled as possible, note the apparent results, and base a conclusion upon these. The conclusions should be the same by both methods provided that on the one hand it is possible to find out not only the amounts but the nutritive office of all the compounds which the food contains, and that on the other hand, perfect control and knowledge of every factor involved in a feeding experiment can be secured. In neither case are we now able to realize a satisfactory standard of work, and so in comparing the two methods it is only a question of which one can be so carried out as to be entitled to the greater degree of confidence.

Of course the ultimate appeal must in a general way always be to the animal, and the strongest conclusions are those supported both by theoretical considerations and actual results.

A question may arise, however, where from the standpoint of the chemist a clear answer is given, which answer is not ratified by the results of a feeding experiment, as to which is at present the more reliable basis of judgment, the knowledge gained by a chemical study of the food, or the apparent outcome of an actual feeding trial. For instance, it is desired to compare the feeding value of bran and fine middlings. The composition of the two is found not to differ greatly so far as it is a question of the relative amounts of the several classes of compounds, and the digestibility of the former is found to be much less than that of the latter. These facts regarded in the light of approved theories, warrant the conclusion that the feeding value of the middlings is the greater. But a feeding trial in which rations, containing in some periods bran and in others, middlings, are compared, either does not show the expected difference, or declares one altogether larger than other facts seem to warrant. Are we, then, to conclude the theory is wrong? Certainly not from a single trial. So many conditions, such as the lengthening of the period of lactation, the temperature of the barn, variations in weight due to a change in intestinal contents, and the unreckoned or unmeasured increase or decrease of the flesh of the animal (if with cows), enter into a feeding trial as unknown factors, that such differences as exist between two grain foods may either be covered up or greatly exaggerated. Nothing short of several feeding trials should be allowed to throw a doubt upon the correctness of theories that appear to be well substantiated by severe methods of investigation, and even then the points of disagreement would, doubtless, be regarded as unsettled questions.

Fortunately, however, the value to farm practice of the feeding trials here reported is not lessened by apparent discrepancies between the outcome which general principles would seem to dictate and the results actually reached. The experiments which are discussed in this connection are the following:

(1) The relative feeding value of Southern corn silage and Maine field corn silage.

(2) The influence of widely differing rations upon the quantity and composition of milk.

(3) Experiments with swine.

(*a*) Relative economy of production with different breeds.

(*b*) The market value of different breeds.

(*c*) The comparative value of nutrients from skimmed milk and from vegetable foods.

(*d*) The economy of production at different ages.

FEEDING EXPERIMENTS WITH COWS.

THE RELATIVE FEEDING VALUE OF SOUTHERN CORN SILAGE AND MAINE FIELD CORN SILAGE.

The discussion on previous pages of the comparative composition and digestibility of Southern corn and Maine field corn, makes plain three facts:

1st. The Maine Corn contains less water or more dry matter than the other.

2nd. The dry matter of the Maine Field Corn is the more digestible of the two kinds.

3rd. This difference is due to the formation in the Maine Field Corn, while maturing, of compounds that are wholly digestible and of the highest nutritive value.

These facts as plainly declare as facts can that the one variety of corn is worth much more than the other in feeding value, if equal weights are compared. Can this be shown in practice? Will the animal ratify the conclusion that the digestible dry matter, when judging foods of the same class, is a safe standard of comparison? What is the influence of maturity on the value of the digestible dry matter as shown by experience?

These questions as related to silage corn were submitted to the test of a feeding experiment for milk production in the winter of 1892-3. The plan of the experiment was a simple one. It was divided into three periods, of about one month each, the only essential changes in the rations of the several periods being a substitution of one kind of silage for the other. It was intended to supply the same quantity of digestible material from each of the two kinds of silage. This was not done, however, because it was not possible to ascertain the actual composition and digestibility of these materials until during the time they were being fed, and more digestible dry substance was consumed in the Maine Field Corn Silage than in the other. The data noted in this experiment include:

(1) The weights of food consumed.

(2) The composition and digestibility of the foods.

(3) The weights of water drank.

(4) Variation of the live weights of the cows. (The cows were weighed on three successive days of each week.)

(5) The yield of milk. (Each mess of milk was weighed.)

(6) The composition of the milk. (Each mess of milk was analyzed for five successive days during the last week of each period.)

From the facts supplied by such a collection of data it was hoped to derive evidence of a somewhat decisive character, so far as this can be accomplished by a single experiment. These data are displayed in the several tables of figures which follow.

RATIONS.

Period 1.	Nov. 21st to Dec. 18th,	14 pounds Barley Hay. 40 pounds Southern Corn silage (No.CLXX). 6 pounds grain mixture.
Period 2.	Dec. 19th to Jan. 18th,	14 pounds Barley Hay. 30 pounds Maine Field Corn silage (No. CLXXI). *6 pounds grain mixture.
Period 3.	Jan. 19th to Feb. 16th,	12 pounds Timothy Hay. 40 pounds Southern Corn silage (No. CLXXVI). *6 pounds grain mixture.

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* The cow Nancy Avondale was fed 7 pounds grain mixture.

TABLE XXXIII.

COMPOSITION OF FOODS.

	Dry matter.	Digestible material.			
		Organic matter.	Protein.	Carbo-hydrates.	Fat.
	%	%	%	%	%
Southern Corn silage, CLXX *.. ..	13.5	8.3	1.10	6.8	.35
Southern Corn silage, CLXXVI *.. .	16.2	10.0	1.70	7.8	.30
Field Corn silage, CLXXI	22.8	16.8	1.50	14.7	.65
Barley Hay*...........................	85.87	50.3	7.4	40.6	1.00
Timothy Hay...........................	87.50	48.2	3.83	42.9	1.75
Corn meal	89.4	77.3	8.0	65.4	4.25
Bran..................................	88.5	51.8	13.2	34.8	2.9
Gluten meal	90.4	76.9	22.9	48.7	5.35
Cotton seed meal	91.8	68.5	36.8	17.9	12.2

* The composition and digestibility of these foods were actually determined. For the other foods average figures were used.

TABLE XXXIV.

NUTRANTS IN DAILY RATIONS,—(POUNDS).

		Dry matter.	Total organic matter.	Protein.	Carbo-hydrates.	Fats.
*First period		22.7	14.23	2.47	11.15	.41
*Second period........		24.0	16.00	2.47	12.84	.71
*Third period.		22.4	14.00	2.07	11.02	.81
Nancy Avondale	Second period.....	24.9	16.7	2.63	13.3	[illegible]
	Third period...	23.2	14.5	2.23	11.4	[illegible]

* The same for all cows except Nancy Avondale.

TABLE XXXV.

WATER DRANK DAILY.

	Agnes—pounds.	Dins.—pounds.	L. T.—pounds.	Shaw—pounds.	N. A.—pounds.
First period	52.4	56.8	48.1	53.0	
Second period	51.4	56.5	48.0	51.9	65.6
Third period	45.9	48.9	45.7	40.8	57.4

TABLE XXXVI.

WEIGHTS OF THE COWS.

FIRST PERIOD.	Agnes.	Dins.	L. T.	Shaw.	N. A.
First week	*870	867	836	965	
Second week	870	853	831	958	
Third week	863	843	834	955	
Fourth week	861	850	840	945	
Average	866	853	835	956	
SECOND PERIOD.					
First week	845	847	821	938	990
Second week	837	832	816	929	990
Third week	834	830	823	946	987
Fourth week	833	832	820	946	986
Average	837	835	820	940	988
THIRD PERIOD.					
First week	843	843	830	963	965
Second week	852	845	835	976	958
Third week	838	841	837	959	955
Fourth week	840	845	833	952	945
Average	843	843	834	962	956

* Each number represents the average of three weighings.

TABLE XXXVII.

MILK YIELD,—POUNDS PER WEEK.

	N. A.	Agnes.	Dins.	L. T.	Shaw.
November 27th to December 18th, inclusive, 22 days.					
First week		185.4	181.4	175.9	141.3
Second week		176.3	177.5	170.1	138.6
Third week		174.3	174.7	166.1	142.1
Last day		26.5	24.6	25.3	20.0
Total yield		562.4	558.3	537.4	442.0
Average daily yield		25.6	25.3	24.4	20.1
December 25th to January 18th, inclusive, 25 days.					
First week	246.3	172.6	169.5	173.0	139.1
Second week	239.9	176.5	177.4	175.8	143.9
Third week	236.7	172.3	175.6	164.7	137.1
Last four days	138.9	98.0	99.1	98.6	73.9
Total yield	861.7	619.4	621.6	612.2	494.0
Average daily yield	34.5	24.8	24.9	24.5	19.8
January 22d to February 16th, inclusive, 26 days.					
First week	224.0	159.0	167.7	172.7	131.0
Second week	225.0	158.5	162.0	167.4	127.6
Third week	214.1	153.4	157.6	164.5	127.5
Last five days	151.3	106.4	108.9	112.5	88.7
Total yield	814.4	577.4	596.3	617.1	474.9
Average daily yield	31.3	22.2	22.9	23.7	18.3

TABLE XXXVIII.

AVERAGE DAILY YIELD OF MILK.

	Agnes. Pounds.	Dins. Pounds.	L. T. Pounds.	Shaw. Pounds.	N. A. Pounds.
First period, Nov. 27th to Dec. 18th—22 days	25.6	25.3	24.4	20.1	
Second period, Dec. 25th to Jan. 18th—25 days	24.8	24.9	24.5	19.8	34.5
Third period, Jan. 22d to Feb. 16th—26 days	22.2	22.9	23.7	18.3	31.3

TABLE XXXIX.

AVERAGE COMPOSITION OF FIVE DAYS' MILK IN EACH PERIOD.

	Agnes.		Dins.		L. T.		Shaw.		N. A.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
	%	%	%	%	%	%	%	%	%	%
First period	13.44	4.4	14.02	4.5	12.99	3.9	14.22	4.8		
Second period	14.09	4.8	14.56	4.9	13.84	4.4	15.16	5.4	12.05	3.2
Third period	14.02	4.9	14.68	5.1	13.46	4.4	14.72	5.3	11.66	3.0

TABLE XL.

DAILY YIELD OF MILK SOLIDS,—POUNDS.

	Agnes.	Dins.	L. T.	Shaw.	N. A.	Average.
First period	3.43	3.55	3.17	2.85	-	3.24
Second period	3.49	3.62	3.39	3.00	4 15	*3.37
Third period	3.11	3.37	3.19	2.69	3.65	*3.09

* N. A. not included in these averages.

TABLE XLI.

POUNDS DIGESTIBLE FOOD EATEN FOR EACH POUND MILK SOLIDS PRODUCED.

	Agnes.	Dins.	L. T.	Shaw.	N. A.	Average.
First period	4.16	4.00	4.49	4.99	-	4.41
Second period	4.58	4.42	4.72	5.33	4.02	*4.79
Third period	4.50	4.15	4.39	5.20	4.00	*4.56

* Averages, excluding N. A.

It appears that in the first two feeding periods fourteen pounds of barley hay and mixed grain were fed besides the silage, and that in the third period twelve pounds of Timothy hay took the place of the barley hay. Forty pounds of Southern corn silage were fed in the first and last periods and thirty pounds of Field corn silage in the middle or second period. The daily digestible food for each of the three periods was 14.23 pounds, 16 pounds and 14 pounds respectively, so that the substitution of thirty pounds of Maine field corn silage for forty pounds of Southern corn silage had the effect of increasing the daily composition of digestible material by nearly two pounds. The fact that the daily ration of digestible material did not remain practically the same in all periods, introduces an element of uncertainty into the conclusions which may be drawn.

The relative effect of these rations must be seen, if at all, by studying their effect upon the bodily condition of the animals and upon the production of milk. If we do this we find that the cows lost from fifteen to thirty pounds weight in passing from the first to the second periods and that this loss was partially regained during the third period. These changes in live weight can be readily explained by the less weight of silage eaten in the second period, with no marked change in the quantity of water drank in any period.

Ordinarily in an experiment of this kind, extending through three months or more, there is a gradual but continuous decrease in the volume of the milk yield, unless there is a change in the food favorable to an increased milk production. When we see that in the second period of this experiment practically the same weight of milk was produced, and that owing to an increase in the dry matter of the milk there was actually a larger production of milk solids, we have good presumptive evidence that the ration containing the thirty pounds of Field corn silage was more efficient than the previous ration containing forty pounds of Southern corn silage. This evidence is strengthened by the fact that when in the third period a return is made to the Southern corn silage the yield of milk solids is decidedly diminished. Nevertheless, as stated in the preliminary discussion of feeding experiments, minor differences in two rations, such as existed in this experiment are not easily measured where so many uncontrolled and unmeasured factors exist.

The best possible analysis of the evidence that is secured in this case seems, however, to be entirely in favor of the conculsion that pound for pound the Maine Field Corn Silage was worth more than the Southern Corn silage, and that the difference was practically in the proportion of the amount of digestible dry substance in the two materials. This is the result which a careful consideration of the facts learned in other ways would lead us to expect.

THE INFLUENCE OF WIDELY DIFFERING RATIONS UPON THE QUANTITY AND QUALITY OF MILK.

There is no question more generally discussed by dairymen just at this time than the influence of the food of a cow upon the amount and kind of milk. It is agreed on all sides that the quantity of milk is up to a certain limit very largely dependent upon the quantity and kind of food. Many farmers also express themselves as convinced that the quality of milk is materially modified by the kind of food, and so we hear such expressions as "feeding for milk" and "feeding for butter," as though a ration that will cause an increased flow of milk will not necessarily increase the butter production.

The opinion largely held by agricultural chemists and others who regard this question in the light of the results of experiment and investigation, is that the quality of milk is practically controlled by the individuality of the animal and that within the limits of healthful feeding the composition of the milk is not to be greatly influenced by the kind of food. It is conceded that marked changes occur in the milk of the same animal, such as daily variations, and variations due to protracted lactation, changes of season, weather and other causes not well defined. The fat in the milk may differ one per cent on two successive days, without apparent cause, although at other times a reasonable explanation may appear. The fact that when cows are fed each day exactly the same quantity of the same kind of food the milk does not remain constant in composition, but varies to a material extent, furnishes an element of uncertainty in interpreting the results of those feeding experiments which have for their object a study of the influence of food upon milk. It is not always easy to become satisfied that any change in the milk is due to a known cause.

Many experiments have been carried on for the purpose of throwing light upon the problem here presented, and while the testimony is largely on one side, it is to some extent conflicting. Up to the present date, however, the concensus of opinion is as before stated, that the animal is the determinative factor. There are numerous facts in common experience which accord with this opinion. Every farmer recognizes marked differences in the milk of the several animals in his herd and he is well aware that by no sort of manipulation of food can he obliterate these differences and reduce the milk of all his different animals to a dead level of quality. Whatever practice he may adopt in feeding he will still have "poor-milk" cows and "rich-milk" cows. It is a matter of common observation that certain breeds furnish milk of a characteristic quality and no one has yet discovered a way of converting a Jersey's milk into the kind the larger and more showy Holstein yields, neither do we know how to coerce the latter into supplying us with the richness of color and composition which we have imported from the Channel Islands. It is reasonable to regard lactation as a function, which, both as to the kind and the maximum quantity of the product, is fixed chiefly by the constitutional limitations of the individual.

It has been supposed possible for changes in the food to cause the composition of the resulting milk to vary in two ways, viz: by increasing or decreasing the percentage of solid matter, and by changing the composition of the solids, as for instance, increasing the fat without a corresponding increase of casein.

The experiment with cows, the results of which are given in this connection, was planned with reference to changes in the rations so radical as to induce if possible corresponding variations in the character of the milk. The attempt was not to compare a starvation diet with liberal feeding, because no one believes a starvation ration to be wise or profitable, and liberal feeding is universally regarded as a part of the creed of successful agriculture. But while there is a general agreement that the ration should be generous in quantity and agreeable in quality, there is much discussion as to the way in which this ration should be compounded and the relative effcet of different mixtures of the nutrients, and so the rations in this experiment were made to differ very widely in the relation of the nitrogenous to the non-nitrogenous nutrients.

The experiment was begun with four cows, one of which was dropped out and results are reported from only three. The three feeding periods covered one hundred and five days, or thirty-five days each.

The three cows were designated as A, R, and L. T. The two rations compared were as follows:

RATION 1.

Timothy hay	ad lib.
Corn meal	2 pounds.
Cotton-seed meal	2 pounds.
Gluten meal	2 pounds.

RATION 2.

Timothy hay	ad lib.
Corn meal	6 pounds.

Ration 1 was fed to A during the first and third periods, and to R and L. S. during the second or middle period. Ration 2 was fed to A in the middle period and to R and L. S. in the first and third periods.

A record was made of the food consumed and of the weights of milk produced. During the last five days of each period the milk was analyzed. The butter was also submitted to tests for melting points, the percentages of volatile acids and for the iodine absorption equivalent.

The data are all given in the subsequent tables.

TABLE XLII.

FOOD EATEN.

Cow A.

Period 1.	Period 2.	Period 3.
804 lbs. Timothy hay. 70 lbs. corn meal. 70 lbs. gluten meal. 70 lbs. cotton-seed meal.	740 lbs. Timothy hay. 210 lbs. corn meal.	750 lbs. Timothy hay. 70 lbs. corn meal. 70 lbs. gluten meal. 70 lbs. cotton-seed meal

Cow R.

Period 1.	Period 2.	Period 3.
777 lbs. Timothy hay. 210 lbs. corn meal.	770 lbs. Timothy hay. 70 lbs. corn meal. 70 lbs. gluten meal. 70 lbs. cotton-seed meal.	710 lbs. Timothy hay. 210 lbs. corn meal.

Cow L. T.

Period 1.	Period 2.	Period 3.
777 lbs. Timothy hay. 210 lbs. corn meal.	770 lbs. Timothy hay. 70 lbs. corn meal. 70 lbs. gluten meal. 70 lbs. cotton-seed meal.	680 lbs. Timothy hay. 210 lbs. corn meal.

AVERAGE WEIGHTS OF COWS,—POUNDS.

	Cow A.	Cow R.	Cow L. T.
First period	876	859	866
Second period	872	853	837
Third period	846	840	831

TABLE XLIII.

DAILY RATIONS IN TERMS OF DIGESTIBLE NUTRIENTS,—POUNDS.

PERIOD 1.	Cow 1.	Cow 2.	Agnes.
Dry substance	24.8	24.8	25.5
Organic digestible matter	15.3	15.3	15.6
Digestible protein	1.21	1.21	2.12
Digestible carbohydrates	13.4	13.4	12.5
Digestible fats	.64	.64	.85
Nutritive ratio	1: 12.3	1: 12.3	1: 6.8
PERIOD 2.			
Dry substance	24.7	24.7	23.8
Organic digestible matter	15.1	15.1	14.8
Digestible protein	2.09	2.09	1.18
Digestible carbohydrates	12.07	12.07	12.97
Digestible fat	.84	.84	.63
Nutritive ratio	1: 6.7	1: 6.7	1: 12.3
PERIOD 3.			
Dry substance	23.1	22.3	24.1
Digestible organic matter	14.4	14.	14.8
Digestible protein	1.15	1.13	2.06
Digestible carbohydrates	12.62	12.24	11.82
Digestible fats	.81	.60	.82
Nutritive ratio	1: 12.3	1: 12.00	1: 6.6

TABLE XLIV.

YIELDS OF MILK.

Period 1. (December 12th to January 15th inclusive.)

	Cow A. Nitrogenous ration.—pounds.	Cow R. Corn meal ration.—pounds.	Cow L. T. Corn meal ration.—pounds.
First week	172.0	126.5	128.7
Second week	185.9	114.2	120.8
Third week	182.0	128.5	128.0
Fourth week	183.2	106.6	116.4
Fifth week	190.6	108.7	112.9
Total for last four weeks	741.7	458.1	478.0
Average per day	26.5	16.4	17.4

Period 2. (January 16th to February 19th inclusive.)

	Cow A. Corn meal ration.—pounds.	Cow R. Nitrogenous ration.—pounds.	Cow L. T. Nitrogenous ration.—pounds.
First week	175.4	129.2	117.3
Second week	151.8	149.1	139.7
Third week	146.0	149.8	135.6
Fourth week	133.2	141.6	130.2
Fifth week	129.3	146.1	128.6
Total for last four weeks	560.2	580.6	534.2
Average per day	20.0	20.7	19.1

TABLE XLIV—CONCLUDED.

Period 3. (February 20th to March 25th inclusive.)

	Cow A. Nitrogenous ration.—pounds.	Cow B. Corn meal ration.—pounds.	Cow L. T. Corn meal ration.—pounds.
First week	154.4	124.1	114.0
Second week	176.8	108.1	110.5
Third week	172.5	106.3	100.7
Fourth week	172.4	95.4	98.9
Fifth week	169.3	84.0	87.8
Total for last four weeks	691.0	393.8	397.9
Average per day	24.7	14.1	14.2

SUMMARY.

	Cow A. Pounds.	Cow B. Pounds.	Cow L. T. Pounds.
Average total yield on nitrogenous ration	716.4	580.6	534.2
Average total yield on corn meal ration	560.2	425.9	437.9
Excess of yield with nitrogenous ration	156.2	154.7	96.3
Daily yield with nitrogenous ration	25.6	20.7	19.1
Daily yield with corn meal ration	20.0	15.2	15.6
Daily excess with nitrogenous ration	5.6	5.5	3.5

TABLE XLV.

COMPOSITION OF THE MILK.

		Total solids. %	Casein and albumen. %	Fat. %
Cow A.,	First period, nitrogenous ration.	14.06	3.76	4.70
	Second period, corn meal ration.	13.39	3.45	4.24
	Third period, nitrogenous ration	14.17	3 51	4.74
Cow R.,	First period, corn meal ration....	13.26	3.47	4.07
	Sec'nd period, nitrogenous rat'n,	13.92	3.67	4.77
	Third period, corn meal ration..	14.03	3.38	4.84
Cow L. T.,	First period, corn meal ration...	13.38	3.48	3.99
	Sec'nd period, nitrogenous rat'n,	14.27	3.67	4.72
	Third period, corn meal ration..	13.62	3.12	4.55

TABLE XLVI.

YIELD OF MILK SOLIDS.

		In 28 days.	In one day.
Cow A.,	First period, nitrogenous ration	104.3 pounds	3.72 pounds
	Second period, corn meal ration	75.0 pounds	2.68 pounds
	Third period, nitrogenous ration	97.9 pounds	3.50 pounds
Cow R.,	First period, corn meal ration	60.7 pounds	2.17 pounds
	Second period, nitrogenous ration	80.8 pounds	2.88 pounds
	Third period, corn meal ration	55.3 pounds	1.97 pounds
Cow L. T.,	First period, corn meal ration...........	63.9 pounds	2.28 pounds
	Second period, nitrogenous ration.......	76.2 pounds	2.72 pounds
	Third period, corn meal	54.2 pounds	1.93 pounds

SUMMARY.

	Cow A.	Cow R.	Cow L. T.
	Pounds.	Pounds.	Pounds.
Av. daily yield milk solids on nitrogenous ration,	3.61	2.88	2.72
Av. daily yield milk solids on corn meal ration..	2.68	2.07	2.10
Excess with nitrogenous ration...............	.93	.81	.62

TABLE XLVII.

RELATION IN QUANTITY OF THE COMPOUNDS OF THE MILK.

Cow A.	Relation of casein to fat. Casein=100.	Relation of fat to total solids. Fat=100.
First period, nitrogenous ration	100:126	100:300
Second period, corn meal ration	100:128	100:315
Third period, nitrogenous ration	100:135	100:290
Cow R.		
First period, corn meal ration	100:117	100:335
Second period, nitrogenous ration	100:130	100:293
Third period, corn meal ration	100:142	100:290
Cow L. T.		
First period, corn meal ration	100:115	100:335
Second period, nitrogenous ration	100:129	100:302
Third period, corn meal ration	100:146	100:309

TABLE XLVIII.

BUTTER CHARACTERISTICS.

Cow A.	Melting point. C°.	Volatile acids.	Iodine equivalent.
First period, nitrogenous ration	33.2	32.9	28.0
Second period, corn meal ration	34.0	29.9	26.7
Third period, nitrogenous ration	33.1	30.1	30.0
Cow R.			
First period, corn meal ration	34.0	32.6	30.0
Second period, nitrogenous ration	33.2	31.4	29.4
Third period, corn meal ration	34.2	32.8	28.6
Cow L. T.			
First period, corn meal ration	31.1	33.2	33.1
Second period, nitrogenous ration	29.3	30.7	34.6
Third period, corn meal ration	30.0	30.8	34.3

The foregoing data, which as stated, are the result of an attempt to study the influence of widely varying rations upon the production and characteristics of milk, give conclusive evidence in regard to but one of the several points considered. The figures tabulated give information about,

(1) The total and digestible food consumed.
(2) The body weights of the animals.
(3) The milk yield.
(4) The composition of the milk.
(5) The yield of milk solids.
(6) The composition of the milk solids.
(7) Certain chemical and physical characteristics of the butter fat.

A review of these data warrant the following summary:

(1) Milch cows were fed two rations differing widely in the amount of protein which they contained. The hay was the same in both, also the weight of grain, but in one the grain consisted wholly of corn meal while in the other it was made up of cotton-seed, gluten and corn meals in equal parts.

(2) Both rations furnished practically the same amount of digestible material. The proportion of digestible protein was nearly twice as great in the mixed grain ration as in the corn meal ration.

(3) The cows did not vary greatly in body weight, but their general appearance showed less thrift while being fed the corn meal ration.

(4) The yield of milk from the nitrogenous ration was from one-fifth to more than one-third larger than that from the corn meal ration, the excess ranging with the three cows from 20 per cent to 36 per cent, or an average of about five pounds of milk per day.

(5) In general the milk was materially richer while the cows were fed the ration rich in protein, though with one cow it showed the largest percentage of solids during the third period while she was eating the corn meal ration. With the other two cows the influence of the mixture of cotton-seed meal, gluten meal and corn meal in increasing the per cent of solids of the milk seemed quite marked.

(6) The daily yield of milk solids was from thirty to forty per cent greater with the more nitrogenous ration.

(7) The composition of the milk solids seemed to be independent of the ration. In general the proportion of fat increased throughout the experiment without regard to what the cows were fed, and no evidence is furnished in support of the notion that by changing the food it is possible to produce more butter fat without an accompanying increased production of the other milk solids. In other words, it appears that the most profitable food for butter production will also be most profitable for the milk farmer or cheese maker. The relation of fat to the other solids seems to be determined by the animal or by certain unknown conditions of environment rather than by the food.

(8) So far as could be learned by chemical tests, the butter made from the two rations was not greatly different.

FEEDING EXPERIMENTS WITH SWINE.

More or less experimental feeding with swine has been going on at the station since the last report that was made of similar work in 1890. These experiments have been practical rather than scientific, and have not resulted as satisfactorily in all respects as was desired. They have centered chiefly around two main considerations: First, the relative economic value of several breeds of swine, special attention being paid to the Tamworths, and to a cross of this breed with the Berkshire; second, the relative value of the dry matter of skimmed milk and an equivalent amount of digestible material from some nitrogenous vegetable food.

The Tamworth swine used as a basis of these experiments were a fine pair of these animals presented to the station by J. M. Sears, Esq., of Boston, Mass., to whom the station is greatly indebted. The female has produced several litters of pigs, and certain of these have been used in the feeding tests. Crosses have also been secured by the use of the Tamworth male and Berkshire females, and as will be seen by the results obtained, these animals have proved to be desirable.

Three lots of animals have been grown from young pigs to a marketable condition. The first lot included Cheshires, Jersey Reds and White Chesters, the second lot Tamworths and Tamworth-Berkshires, and the third lot Tamworths, Berkshires and Tamworth-Berkshires.

The first lot lived mostly in pens out of doors, having shelter from inclement weather. The other lots were grown in indoor pens.

A careful record of food consumed and weights of animals was kept. The food was weighed daily and the animals once a week.

The foods were not analyzed, but are assumed to have the average composition, which for milk and grains may be safely regarded as involving only a small error.

By the use of the figures given in Jenkins' and Winton's tables, and of digestion co-efficients selected from American and German work, the following percentages of digestible material are found to be contained in the food used in these experiments, and these percentages have been applied in calculating the digestible organic nutrients actually consumed.

TABLE XLIX.

COMPOSITION OF FOODS USED IN FEEDING EXPERIMENTS WITH SWINE.

	Dry matter in 100 pounds.	Digestible nutrients in 100 pounds.			
		Total organic matter.	Protein.	Carbo-hydrates.	Fats.
Corn meal	89.4	80.8	8.8	74.3	3.65
Fancy middlings	89.3	67.3	12.0	53.6	3.2
Gluten meal	90.4	82.5	25.3	49.8	4.85
Mangolds*	11.7	9.0	.93	8.1	.12
Oats (ground)	89.0	60.2	9.1	47.2	4.15
Pea meal	89.5	79.2	17.8	59.4	.59
Skimmed milk	10.0	9.2	3.5	5.2	.5
Sugar beets*	16.2	15.0	1.42	13.4	.07

* Actual analyses were made of these materials.

In the tables which succeed, may be found a statement of the results of these experiments.

TABLE L.

EXPERIMENT OF 1891 WITH SWINE.

	White Chester.	Jersey Red.	Cheshire.
Number of animals	2	2	1
Days fed	140	157	157
Skimmed milk consumed*	1800	1884	1256
Middlings consumed	1056	1123	663
Total dry matter consumed	1123	1191.2	717.6
Digestible protein consumed	189.7	200.7	123.5
Digestible carbohydrates consumed	659.5	699.9	420.7
Digestible fats consumed	42.8	45.3	27.5
Total digestible matter consumed, (organic)	892.0	945.9	571.7
Dry matter consumed daily	4.01	3.79	4.57
Digestible organic matter consumed daily	3.18	3.01	3.64
Initial weight of pigs	129	114	82
Last weight of pigs	449	437	265
Total gain of pigs	320	323	183
Daily gain of pigs	1.15	1.03	1.16
Digestible organic matter eaten per pound of gain	2.78	2.93	3.12

* All figures representing weights are in pounds.

TABLE LI.

EXPERIMENT OF 1891-2.

Early Growth of Tamworths and Tamworth-Berkshires.

	Lot 1. Skimmed milk with grain.		Lot 2. Grain ration, no milk.	
	Tamworth pigs.	Tamworth-Berkshire pigs.	Tamworth pigs.	Tamworth-Berkshire pigs.
Number of animals	2	3	2	2
Days fed	126	98	126	98
Skimmed milk consumed	2,506	2,184		
Corn meal consumed	211.0	273.0	254.5	
Sugar beets consumed	422	-	427	
Mangolds consumed	-	294	-	196
Gluten meal consumed	-	-	254.5	
Peas consumed	-	-	-	182.5
Oats consumed	-	-	-	182.5
Dry matter consumed	507.7	496.8	527.5	348.5
Dry matter consumed daily	2.01	1.69	2.09	1.78
Digestible protein consumed	112.3	103.3	92.5	51.1
Digestible carbohydrates consumed	328.2	319.3	354.4	210.2
Digestible fats consumed	20.9	21.5	22.4	8.9
Digestible organic matter consumed	461.4	444.1	469.3	270.2
Digestible organic matter consumed daily	1.85	1.52	1.90	1.39
Initial weight of pigs	73.0	81.0	75.0	53.0
Last weight of pigs	217.0	260.0	199.0	132.0
Total gain of pigs	144.0	179.0	124.0	79.0
Daily gain per pig	.57	.61	.48	.40
Digestible organic matter eaten for each pound of gain	3.18	2.48	3.78	3.42

TABLE LII.

EXPERIMENT 1891-2, (Continued).

Later, Growth Tamworths, and Tamworth-Berkshires.

	Lot fed more skim-milk.	Lot fed less skim-milk.
Number of animals	2	2
Days fed	148	148
Skimmed milk consumed	4,116	2,058
Corn meal consumed	1,435	1,435
Pea meal consumed		147
Oat meal consumed		147
Dry matter consumed	1,694.5	1,750.9
Dry matter consumed daily per pig	5.72	5.91
Digestible protein consumed	271	238.7
Digestible carbohydrates consumed	1,175.4	1,225.1
Digestible fats consumed	75.8	72.5
Digestible organic matter	1,522.2	1,536.3
Digestible organic matter fed daily per pig	5.15	5.20
Initial weight of pigs	208	218
Last weight of pigs	676	691
Total gain	468	473
Daily gain per pig	1.58	1.60
Digestible organic matter eaten per pound of gain	3.26	3.27

TABLE LIII.

EXPERIMENT 1892.

Period 1. Food, Skimmed Milk and Ground Oats.

	Tamworth.	Berkshire.	Tamworth-Berkshire.
Number of animals	4	4	4
Days fed	112	112	112
Skimmed milk consumed	1,792	1,792	1,792
Oat meal consumed	855	1,089	855
Dry matter consumed	940.1	1,103.9	940.1
Dry matter consumed daily per pig	2.10	2.46	2.10
Digestible protein consumed	140.5	157.2	140.5
Digestible carbohydrates consumed	496.8	583.6	496.8
Digestible fats consumed	43.9	52	43.9
Digestible organic matter consumed	681.2	792.8	681.2
Digestible organic matter consumed daily per pig	1.53	1.76	1.53
Initial weight of pigs	74	110	65
Last weight of pigs	397	470	400
Total gain	323	336	335
Daily gain per pig	.72	.75	.75
Digestible organic matter eaten for each pound of gain	2.11	2.36	2.03

TABLE LIII—CONTINUED.

Period 2. Food, Skimmed Milk, Pea Meal and Corn Meal.

	Tamworth.	Berkshire.	Tamworth-Berkshire.
Number of animals	4	4	4
Days fed	42	42	42
Skimmed milk consumed	672	672	672
Pea meal consumed	172.6	200.6	172.6
Corn meal consumed	345.4	401.4	345.4
Dry matter consumed	530.3	606.4	530.3
Dry matter consumed daily per pig	3.15	3.60	3.15
Digestible protein consumed	84.6	94.5	84.6
Digestible carbohydrates consumed	368.5	422.6	368.5
Digestible fats consumed	17.8	20.1	17.8
Digestible organic matter consumed	470.9	537.2	470.9
Digestible organic matter consumed daily per pig	2.80	3.20	2.80
Initial weight of pigs	399	470	400
Last weight of pigs	544	611	546
Total gain	147	141	146
Daily gain per pig	.87	.84	.87
Digestible organic matter eaten for each pound of gain	3.20	3.80	3.20

TABLE LIII—CONTINUED.

Period 3. Food, Mixture Equal Parts Pea Meal, Oat Meal and Corn Meal.

	Tamworth.	Berkshire.	Tamworth-Berkshire.
Number of animals	3	3	3
Days fed	63	49	63
Pea meal consumed	371	253	371
Oat meal consumed	371	253	371
Corn meal consumed	371	253	371
Dry matter consumed	993.0	677.8	993.0
Dry matter consumed daily per pig	5.25	4.61	5.25
Digestible protein consumed	131.4	90.3	131.4
Digestible carbohydrates consumed	643.4	439.5	643.4
Digestible fats consumed	31.3	22.	31.3
Digestible organic matter consumed	806.1	551.8	806.1
Digestible organic matter consumed daily per pig	4.27	3.77	4.27
Initial weight of pigs	438	507	439
Last weight of pigs	638	601	668
Total gain	200	94	229
Daily gain per pig	1.06	.64	1.21
Digestible organic matter eaten for each pound of gain	4.03	5.87	3.52

TABLE LIII—CONCLUDED.

Period 4. Food, Skimmed Milk, Oat Meal and Corn Meal.

	Tamworth.	Berkshire.	Tamworth-Berkshire.
Number of animals	3	3	3
Days fed	56	63	49
Skimmed milk consumed	1,680	1,890	1,470
Oat meal consumed	476.0	402.5	416.5
Corn meal consumed	476.0	402.5	416.5
Dry matter consumed	1,017.0	907.1	891.7
Dry matter consumed daily per pig	6.07	4.94	6.06
Digestible protein consumed	144.5	138.3	126.5
Digestible carbohydrates consumed	631.0	556.5	553.2
Digestible fats consumed	46.4	41.5	40.7
Digestible organic matter consumed	821.9	736.3	720.4
Digestible organic matter consumed daily per pig	4.89	4.01	4.90
Initial weight of pigs	638	601	668
Final weight of pigs	834	801	847
Total gain	196	200	179
Daily gain per pig	1.17	1.06	1.22
Digestible organic matter eaten for each pound of gain,	4.19	3.80	4.02

SUMMARY.

	Tamworth.	Berkshire.	Tamworth-Berkshire.
Number of days fed	273	266	266
Digestible organic matter consumed	2,780	2,618	2,678
Total gain	866	771	894
Digestible organic matter for each pound of gain	3.21	3.40	3.00

RELATIVE GROWTH OF ANIMALS OF THE SEVERAL BREEDS.

The only fair comparison of the economy of production with animals from the several breeds is based upon the digestible food consumed for each pound of growth. The figures showing this have been brought together from the foregoing tables and can be seen in table 54.

TABLE LIV.

RELATION OF FOOD TO GROWTH.

(Pounds digestible organic material for each pound gain.)

	Cheshire.	Poland China.	Yorkshire.	White Chester.	Jersey Red.	Berkshire.	Tamworth.	Tamworth-Berkshire.
Experiment—1890	2.88	2.73	2.50	2.50	-	2.45		
1891	3.12	-	-	2.78	2.98			
1891-2, early growth	-	-	-	-	-	-	3.18	2.48
1891-2, later growth	-	-	-	-	-	-	3.71	2.89
1892, period 1	-	-	-	-	-	2.36	2.11	2.03
1892, period 2	-	-	-	-	-	3.80	3.20	3.20
1892, period 3	-	-	-	-	-	5.87	4.03	3.52
1892, period 4	-	-	-	-	-	3.80	4.19	4.02
1892, av. four periods,	-	-	-	-	-	3.40	3.21	3.00

These experiments furnish no evidence of the superior producing capacity of any one of the breeds tested. It should be observed that with the exception of the Tamworths, Berkshires and the Tamworth-Berkshire cross the number of animals grown was too small to allow conclusions of much value.

It is certainly true of the Tamworth-Berkshire cross that the animals were finely formed and vigorous, and they certainly used food more economically than either the pure bred Tamworths or Berkshires. This cross has been admired by all who have seen it, and the market quality of their carcasses was highly commended.

BUTCHERS' ANALYSIS OF THE CARCASSES.

It is evident that the present demands of the market are for pork of a somewhat different kind than was the case formerly. Now the retail meat trade calls for a rather small carcass that will cut a large proportion of lean parts, and as the lean cuts bear a higher price than "clear pork" it is for the interest of both farmer and dealer that animals be grown which will supply the requirements of the market. Farmers are surely making a mistake in supposing that the fattest animals are certainly the most profitable. It is at least true that such animals tend to aggravate rather than amend the unbalanced diet to which Americans are so much given.

It was hoped that in the Tamworths would be found a breed of swine which with the use of proper rations would furnish to consumers a larger proportion of lean meat than is the case with the breeds more commonly in use, and in order to learn whether this hope would be realized a butcher's analysis has been made of the carcasses of several lots of animals, including five pure breeds and one cross. The most reliable comparison is that made between the Tamworths, Berkshires and the Tamworth-Berkshire cross. The results of this analysis can be seen in Table LV.

TABLE LV.

BUTCHER'S ANALYSIS OF THE CARCASSES.*

	Dressed weight, pounds.	Weights of separate parts,—pounds.							Per cent of lean cuts.	Per cent of salting pork.
		Hams.	Shoulders.	Spare-ribs.	Breakfast bacon.	Leaf lard.	Head and feet.	Salting pork.		
Cheshire	200	28.5	12	50	-	11	19	-	45	
Chester	171.5	25	13	44	-	7.7	21.5	-	48	
Jersey Red	172.5	25	9	38	-	11.5	18.75	-	41.7	
Berkshire	187	26	12.5	46.2	-	8.5	20	-	45.3	
Berkshire	233	33.5	19.5	48	19	14	22.5	76.5	43.3	32.8
Berkshire	199	31.5	17.5	33	12.5	12.5	18	74.3	41.1	37.3
Berkshire	215	30.5	19.7	49	13.5	12.5	18.2	71.6	46.1	33.3
Average	-	-	-	-	-	-	-	-	43.4	34.4
Tamworth	235	33.7	22.5	58	24.5	13	23	60.3	48.6	25.6
Tamworth	281	38.5	19.5	58.5	22.5	17.7	28.5	95.8	41.4	34.1
Tamworth	236	33.5	20	51	13.2	18.2	21.2	78.9	44.3	33 4
Tamworth	227	32.5	18	47.2	15.2	15	21.2	77.9	43	34.3
Tamworth	208	30.2	18.5	44	12.7	15.2	21	66.3	44.6	31.9
Average	-	-	-	-	-	-	-	-	44.4	31.9
Tamworth-Berkshire	341	43	24	67.5	27.5	21	27.2	130.8	39.4	38.4
Tamworth-Berkshire	292.5	38	25.7	62.5	29.5	16.2	23	97.6	43.2	33.4
Tamworth-Berkshire	234	29.5	20.5	49.7	12.5	16.2	18.2	87.4	42.6	37.3
Tamworth-Berkshire	228	31	18	50	12	15	18.2	83.8	43.4	36.8
Average	-	-	-	-	-	-	-	-	42.1	36.5

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* These pigs were cut up and the parts weighed by Charles York & Co., Bangor, Me., to whom the Station is greatly indebted for this service.

The above figures show the proportional amount of lean cuts in the several animals. The term "lean cuts" is taken to mean the sum of the hams and shoulders trimmed and the spare-ribs.

The data here presented do not warrant the claim that any one of the breeds compared possesses superior market qualities over all the others. The Tamworth's gave a somewhat larger percentage of lean cuts and the Tamworth-Berkshire cross a larger proportion of salting pork. The differences are small, we may believe, compared with those which may be caused by age, food, or individual variations.

THE RELATIVE VALUE OF DIGESTIBLE FOOD FROM ANIMAL AND FROM VEGETABLE SOURCES.

The report of the Maine Experiment Station for 1889 contains an account of experiments which had for their object, in part, a comparison of the dry matter of skimmed milk with the digestible part of pea meal as food for swine. Those experiments indicated a practical equivalence, pound for pound.

This matter has again been brought to a practical test in the experiments now under discussion. The growth of separate lots of pigs, selected from the same litter, and of the same lots of pigs during separate periods, has been compared when fed rations containing practically the same amount of digestible matter, but which was derived from unlike sources. As in the experiments of 1889, pea meal or oat meal was made to take the place of skimmed milk in the proportion of the digestible substance in the two.

In tables LVI and LVII are presented the figures showing the actual food required for a pound of growth.

TABLE LVI.

EXPERIMENT IN WHICH THE SKIMMED MILK WAS REPLACED BY NITROGENOUS FOODS, WHOLLY OR IN PART.

	Digestible organic food consumed for each pound of gain in live weight.		
	Tamworths.	Tamworth-Berkshires.	Mixed lot of Tamworths and Tamworth-Berkshires.
Lot 1—Growth from one to four months.			
Food, skimmed milk, corn meal and beets.............	3.18	2.48	
Food, gluten and corn meal and beets..........	3.78		
Food, pea meal, oat meal and beets		3.42	
Lot 2—Growth from four to nine months.			
Food, skimmed milk* and corn meal.			3.26
Food, skimmed milk† pea meal, oat meal and corn meal			3.27

*Amount of milk daily, thirty pounds.

†Amount of milk daily, fifteen pounds. Part only of the skimmed milk was replaced by the pea and oat meals.

TABLE LVII.

EXPERIMENT IN WHICH ONE RATION CONTAINED PEA MEAL IN THE PLACE OF SKIMMED MILK IN THE OTHER RATION.

	Digestible organic food consumed for each pound of gain in live weight.		
	Tamworths.	Berkshires.	Tamworth-Berkshires.
Growth from 1 to 4½ months. (Period 1.)			
Food, skimmed milk and ground oats.........	2.11	2.36	2.08
Growth from 4½ to 6 months. (Period 2.)			
Food, skimmed milk, pea meal and corn meal.... . .	3.20	3.80	3.20
Growth from 6 to 8½ months. (Period 3.)			
Food, equal parts pea meal, oat meal and corn meal.	4.03	5.87	3.52
Growth from 8½ to over 10 months. (Period 4.)			
Food, skimmed milk, oat meal and corn meal.........	4.19	3.80	4.02

It is very plain that for young pig the rations containing skimmed milk proved superior to those containing the nitrogenous vegetable foods as a substitute. But with the older animals the substitution of pea meal or pea and oat meal for the skimmed milk, wholly or in part, did not materially change the rate of growth or its relation to the digestible food consumed.

In a single case an exception occurs, viz: Period 3 with the Berkshires in the 1892 experiment, where the pure grain ration seemed to check the growth of the pigs. In all other cases the amount of digestible food seems to be the practical measure of efficiency whether its source be animal or vegetable.

WASTE OF FAT IN SKIMMED MILK BY THE DEEP-SETTING PROCESS.*

W. H. JORDAN AND J. M. BARTLETT.

The relative economy of the various methods of creaming milk is a matter which is just now receiving much attention from Maine dairymen. The question which is most frequently asked, especially by those keeping a fairly large herd of cows, is, "Shall I get a separator?"

In comparing the separator with the cold deep-setting process several points demand consideration:

1st. The relative expenditure of money, time and labor.
2d. The relative waste in the skimmed milk.
3d. The relative waste in the buttermilk.
4th. The comparative quality of the product.

Present knowledge leads to the opinion that the cream can be handled with equal economy from the two methods, and that there is not difference enough between well made separator-cream butter and equally well made cold-setting-cream butter to find any practical recognition in the most particular market.

The first two points, then, are the ones concerning which there is still more or less discussion.

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*The matter presented under this head is prepared to be issued as Bulletin No. 5, second series.

The object of this bulletin is to present certain facts, lately ascertained by the Station, bearing upon the second point. These facts were obtained as follows: A representative of the Station, Mr. Hayes, during a certain part of August, September and October last, accompanied the cream collectors of two butter factories, viz: the Turner Centre Factory and the Poland Factory, on their trips to the houses of the patrons, and thoroughly sampled the skimmed milk from twenty-four hours' milk. These samples, which were kept sweet by means of a preservative, were promptly shipped to the Station laboratory, where the per cent of fat was determined. The Turner Factory patrons were visited between August 24th and September 9th, and the Poland Factory patrons, between September 30th and October 10th. Besides the names and addresses of the patrons, Mr. Hayes noted other data, which, when summarized, give the following figures:

No. of farms visited	224
No of cows then milked	1,360
Quarts of milk produced	7,623
No. of herds full-blooded Jerseys	6
“ “ “ grade Jerseys (occasional full-bloods,)	167
“ “ “ full-blood Holsteins	2
“ “ “ grade Holsteins	1
“ “ “ miscellaneous (mixtures of Jersey and other grades, &c.,)	52
“ “ farms using deep setting process	221
“ “ “ “ separator	1
“ “ “ “ shallow pans	2
“ “ “ with ice constantly in tanks	194
“ “ “ out of ice	16
“ “ “ using some ice	5
“ “ “ no record	6

Doubtless some will remark that neither the number of cows kept nor the yield of milk make a very favorable showing for Maine dairymen. It should be remembered, however, that these farms were visited at a season of the year when there would probably be found more dry cows and more in an advanced stage of lactation than at any other time. Besides, a severe drought rendered the past season a particularly unfavorable one.

In regard to the methods of creaming, it appears that but one separator was found, while 221 out of the 224 farmers are using he cold deep-setting process. Of these only sixteen are recorded s being out of ice, while one hundred and ninety-four keep ice in he tanks constantly.

The very great prevalence of Jersey blood is another fact worthy f note, showing the tendency of Maine farms, not only towards airying, but towards a specific purpose, rather than a general pur-ose. cow.

The prevalence of the Jerseys and the almost universal use of ce in the tanks all the time are two conditions very favorable to he best possible results with the deep setting process. The per-entages of fat in skimmed milk from the 224 farms are not given here in detail, only a summary.

Farms with skimmed milk fat .1 per cent. or below.......	41
" " " " " above .1 per cent. and not over .15 per cent.........	67
" " " " " above .15 per cent. and not over .20 per cent...	57
" " " " " .25 per cent...............	19
" " " " " .30 per cent.	11
" " " " " .35 per cent............ ..	3
" " " " " .40 per cent.	6
" " " " " from .5 to .2 per cent... ..	17
Average amount of fat in 100 lbs. skimmed milk (224 farms)........................... .	.239 lbs.
Average amount of fat in 100 pounds skimmed milk excluding seventeen farms where the amount was .5 pounds or over (207 farms)...............	.182 lbs.
Average amount of fat in 100 pounds skimmed milk Turner Centre Factory (157 farms)	.188 lbs.
Average amount of fat in 100 pounds skimmed milk Poland Factory (66 farms)	.357 lbs.
Average for Turner Factory excluding 6 farms over .5 pounds................................	.168 lbs.
Average for Poland Factory excluding 11 farms over .5 pounds.......	.222 lbs.

The above figures are certainly somewhat surprising. They are much more favorable to the cold deep setting process than any heretofore published, of which the writer is aware, and somewhat diminish the argument for the separator, in so far as it pertains to the prevention of waste in the skimmed milk. One hundred and sixty-five of the two hundred and twenty-four herds tested did not exceed .2 per cent. of fat in the skimmed milk, the average being about .15 per cent. By the use of the separator on these farms not over .05 per cent. fat would be saved, or one pound of butter fat to two thousand pounds of skimmed milk, *provided the deep setting process is as successfully used all the time.* It is not claimed that the work of the deep setting process is always as good as this. The facts are stated simply as they are found.

It appears that in seventeen cases the per cent. of skimmed milk fat ranged from .5 to 2. In many instances there appears to be a sufficient cause for this excessive loss. In ten of these cases the supply of ice was exhausted, in one the breed of cows was possibly not adapted to the closest deep-setting creaming, in one instance the cream was taken by "top-skimming" which may easily involve unusual loss, and in five instances the conditions were good, there being no apparent reason for abnormal waste.

IS IT NECESSARY TO SUBMERGE THE CANS?*

In the use of the Cooley tank and cans in our own private dairy operations, our philosophy has not considered it necessary that the cans be submerged in order to secure the cleanest practicable creaming, care only being taken that the iced water be kept above the height of the milk in the cans. Seeing the statement in one of our exchanges that the dairymen at the Connecticut convention jumped on to the claim made by Professor Jordan, that the submergence was not absolutely necessary to good work, for they had proved to the contrary, we at once applied to Professor Jordan to learn whether experiments conducted by him had shown that we, and others following the same method, were losing cream by such practice. In reply he has kindly furnished data on the matter, which we give to the readers of the *Farmer* for their benefit.

PROFESSOR JORDAN'S REPLY.

Two reasons are directly or indirectly put forward why submerging should be secured:

1. The composition of the cream is more uniform when this is done.

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*The following discussion of this question appeared in the *Maine Farmer* on March 1st, 1894, and as it is a matter closely related to the cold setting process for raising cream, and as the data on which the discussion is based was obtained in connection with that presented on the foregoing pages, the liberty is taken to reprint the *Farmer* article in this connection.

2. Less fat is left in the skimmed milk than otherwise would be he case.

No experimental evidence is at hand to show whether the first claim is in accordance with fact or not. The only possible reason hat can be offered, however, why submerging affects the consistency of cream, is that it prevents evaporation and consequent hickening of the surface of the cream. But when the cans are in a closed cabinet, the air over the water must be so saturated with moisture as to preclude evaporation from the cream, even if the cans are not submerged. But this point is scarcely worth arguing, for other unavoidable conditions so influence the composition of cream as to completely overshadow this in effect.

The second claim is the more important, and concerning which a certain amount of data is fortunately available.

As was stated in Bulletin No. 5, just issued from this Station, and published in the *Farmer*, a representative of the Station visited two hundred and twenty-four farms, supplying milk to two creameries, and took samples of the skimmed milk. Among other data he noted the manner of setting the milk, whether ice was in the tanks, whether the cans were submerged or not, and if not, the depth of the water.

In making up the averages presented herewith, it should be stated that the first twenty-five farms are excluded, as no record was made of the depth of the water. There are also excluded a few cases where top skimming was practiced, because uniform conditions should prevail in such a comparison. Again, the cases where no ice was used, or other unfavorable circumstances existed, are not included. With these exceptions, the figures obtained are as follows:

Number of observations made	163
Number with cans submerged or sealed	124
Number with cans not submerged or sealed	39
Per cent skimmed milk fat in submerged or sealed cans	.173
Per cent skimmed milk fat in cans not submerged or sealed	.200

The difference is slightly in favor of submerging, but is not large enough to have any practical importance.

It is noticeable in looking over the records mentioned in the foregoing, that a greater percentage of Jerseys and Jersey grades were found among the patrons of the Turner factory than among those of the Poland factory, the latter owning a somewhat larger proportion of Shorthorn and Holstein grades. For this reason it is possibly more just to compare results among the patrons of the same factory, especially as the "not submerged" cases were more frequent in one case than in the other:

TURNER FACTORY.

Number patrons with cans submerged or sealed	106
Number patrons with cans not submerged or sealed	13
Per cent skimmed milk fat in submerged or sealed cans ...	.169
Per cent skimmed milk fat in cans not submerged or sealed..	.177

POLAND FACTORY.

Number patrons with cans submerged or sealed	18
Number patrons with cans not submerged or sealed	26
Per cent skimmed milk fat in cans submerged or sealed......	.201
Per cent skimmed milk fa tin cans not submerged or sealed..	.211

The records show that where the cans were not submerged or sealed, the depth of water varied from half the height of the can to a level with the handles. Mr. Hayes states that the purpose seemed to be to have the water as high as the milk, or above.

The value of submerging as a means of decreasing the waste of fat in the skimmed milk does not become apparent through the foregoing figures. It should be remembered, however, that in all these cases ice was used and kept in the tanks all the time. If this were not done, the chances would appear to be in favor of submerging, because the greater the volume of water, the less its temperature would be raised by cooling the warm milk.

W. H. JORDAN.

Maine Experiment Station, February 14, 1894.

REPORT OF THE HORTICULTURIST.

W. M. Munson.

Many of the experiments detailed in the following report are repetitions or continuations of those undertaken in previous years. The conclusions reached, though sometimes contradicting those heretofore drawn, are none the less valuable. They are the result of careful study of the problems, and as stated in other connections, conclusions are too often freely drawn from insufficient data.

The cauliflower has been added to the list of vegetables receiving special attention, and our success, from a practical point of view, would indicate that the crop may be profitably grown in this section of the state.

The fruit plantation is not as yet in full bearing, and notes concerning the comparative merits of varieties are reserved for a future report. Several additions were made to the orchard, also to the collection of small fruits, during the past season. Despite the cold winter of 1892-3, very little damage was noticed in our plantations.

Spraying experiments were continued on the lines detailed in my last report. The results obtained, as heretofore, point strongly to the value of the use of the copper solutions in combatting the apple scab. The most valuable preparation yet used is the Bordeaux mixture. We are under special obligations to Mr. Charles S. Pope of Manchester, for the continued use of his orchard and the careful attention given in carrying into effect the instructions of the writer.

Included in this report is a catalogue of the fruits of the state with the approximate value of each. This catalogue is presented only after careful study of the reports of many of the leading fruit-growers in different sections of the state, in response to a series of questions sent out by the writer. It will be found valuable for reference in the selection of fruits for general planting.

I wish to make special mention of the careful and efficient work of my assistant, H. P. Gould.

I—Notes of Cabbages.

As heretofore our work with cabbages was confined to a few questions relative to methods of culture. In all cases the seed was sown in the forcing house April 3d, and the young plants were pricked out into boxes April 24th. The season was exceptionally late and a second handling was necessary, May 17th, before the final transfer to the field May 30th.

"All Head Early" and "Burpee's Safe Crop," two sorts sent for trial by W. Attee Burpee & Co., of Philadelphia, are of the Flat Dutch type. They did not average quite so large nor so early as Early Flat Dutch, but were very uniform in size, of firm texture, and produced a high percentage of marketable heads.

1. *Influence of Transplanting*: For two seasons an experiment has been conducted for the purpose of ascertaining whether plants handled in pots previous to setting in the field, are enough superior to those handled in boxes, to warrant the increased expense.* In 1891 the results were indifferent, while last year indications were strongly in favor of the pot-grown plants. The treatment of the plants was in every respect similar to that given last season, *i. e.* one lot of twenty-five young plants was transferred from the seed flat to three-inch and later to four-inch pots, while a duplicate lot was placed in shallow boxes—two inches apart at the first handling and four inches apart at the second.

The results obtained are shown in table I.

TABLE I.

CABBAGE PLANTS FROM POTS AND BOXES.

VARIETY AND TREATMENT.	Heaviest head—lbs.	Lightest head—lbs.	Average weight—lbs.	Number of heads cracked.	Number of heads immature.	Failed to head.	Ratio.	Remarks.
FLAT DUTCH.								
Pots	15.2	8.9	**10.7**	3	0	0	**1.23**	All cut Aug. 18
Boxes	12.0	2.9	**8.7**	0	1	2	**1.00**	
SAFE CROP.								
Pots	10.0	5.5	**7.4**	0	0	1	**1.34**	
Boxes	9.2	2.4	**4.9**	0	11	2	**1.00**	
ALL-HEAD EARLY.								
Pots	12.0	2.8	**8.3**	1	0	0	**1.60**	
Boxes	8.0	1.1	**5.2**	0	1	0	**1.00**	

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* Report Maine Experiment Station, 1891, p. 84; 1892, p. 61.

As will be seen at a glance plants handled in pots were, in every respect, superior to those from the boxes; thus confirming results obtained last year. In no case did the plants from boxes produce heads equal to the best of those from pots.

Conclusion: The practice of handling cabbage plants in pots previous to setting in the field would seem to be warranted by the results obtained during the past two seasons.

2. *Effects of Trimming:* A test as to the value of the practice of reducing the amount of foliage at time of setting was conducted along the same lines as last season.* The results as shown by table II are almost identical with those obtained in the previous trial.

TABLE II.

EFFECTS OF TRIMMING.

VARIETY.	Number of heads.	Heaviest head—lbs.	Lightest head—lbs.	Average weight—lbs.	Number of heads cracked.	Number of heads immature.	Number of plants not cut.	Ratio.	Date of harvesting.
EARLY SUMMER.									
Trimmed.	9	10.0	4.0	7.9	4	2	1	1.23	Sept. 1.
Not trimmed	8	9.4	3.1	6.4	2	2	1	1.00	Sept. 1.
WORLD BEATER (Brill).									
Trimmed.	7	13.3	6.9	9.5	1	0	1	1.00	Sept. 12.
Not trimmed.	7	14.7	3.5	9.5	2	1	1	1.00	Sept. 12.
WORLD BEATER (Burpee).									
Trimmed	19	15.7	3.3	9.9	0	0	2	1.00	Sept. 12.
Not trimmed	13	16.0	6.2	11.1	3	0	1	1.12	Sept. 12.

As will be observed, the results are almost negative. The first variety, Early Summer, exactly reverses the result given last season, when the ratio was as 1.00 : 1.23 in favor of plants not trimmed. In case of World Beater (Brill) the ratio was neutral as in 1892. The plants used in this test were from the same lot of seed as those grown last year. The third variety gave results slightly in favor of plants not trimmed.

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*Report Maine Experiment Station 1892, p. 60.

Conclusion: The results of two seasons' work indicate that little advantage is derived from the practice of trimming cabbage plants at time of setting.

3. *Holding Plants in Check*: Frequently, because of an unusually late season, or from other unavoidable circumstances growers are unable to set plants in the field as soon as they might desire, or when the plants are ready for the transfer. Such conditions existed in our own experience the present year and to meet the case in hand, at the last handling in the house, May 17, all plants except some for checks were severely headed back. What the usual result might be of course we are unable to say, but indications are certainly favorable to the practice. Our general crop was uniformly good. The results of careful comparison of plants thus treated with others of the same lots not checked are given in table III.

TABLE III.

CHECKING GROWTH.

VARIETY.	Heaviest head—lbs.	Lightest head—lbs.	Average weight—lbs.	Number of heads cracked.	Number of heads immature.	Number of heads not cut.	Ratio.	Date of harvesting.
ALL HEAD (Burpee's).								
Checked	12.0	2.8	**8.3**	1	0	0	**1.14**	August 18.
Not checked	11.6	3.3	**7.3**	0	0	0	**1.00**	August 18.
FLAT DUTCH.								
Checked	15.2	8.9	**10.7**	3	0	0	**1.09**	August 19.
Not checked	13.2	5.6	**9.8**	1	0	0	**1.00**	August 19.
SAFE CROP (Burpee's).								
Checked	10.0	5.5	**7.4**	0	0	1	**1.00**	August 18.
Not checked	10.2	6.4	**8.6**	0	0	1	**1.16**	August 18.
RED.								
Checked	13.2	5.3	**8.0**	2	0	1	**1.13**	September 12.
Not checked	11.3	1.3	**7.1**	1	2	0	**1.00**	September 12.

In most cases plants headed back at the last transplanting in the house were superior to those not thus checked. They were uniformly earlier, and were as a rule slightly larger. It is probable that the time elapsing between the check and the transfer to the field allowed the plants to recuperate and make a sturdy growth; while plants not treated were necessarily more or less drawn and not in as good condition for the final transfer.

Conclusion: Cabbage plants likely to become drawn and crowded before planting out, appear to be benefited by severe pruning of the foliage.

II—NOTES OF CAULIFLOWERS.

The cauliflower is a vegetable highly prized by many, but is too seldom met in the home gardens of our State. Possessing many of the good qualities of the cabbage it is, to a certain extent lacking in the peculiar rank flavor which renders the former disagreeable to many people. The delicate qualities of the cauliflower are, however, frequently disguised or lost through failure of the housewife to familiarize herself with the best methods of serving. For this reason we have given below some notes concerning the cooking of cauliflowers, condensed from material kindly furnished by Miss Anna Barrows, School of Domestic Science, Boston.

1. *Directions for Serving the Cauliflower:* A cabbage or cauliflower, unless taken directly from the garden is much improved if so placed that it can absorb water through its stalk for twelve to twenty-four hours before cooking. Soak a cauliflower, head down, in cold salted water for an hour before cooking to draw out any insects that may be concealed. A small cauliflower may be cooked whole and should be placed in the kettle with the flowerets up as the stalk needs the most thorough cooking; a large head should be divided into six or eight pieces.

Cook in a kettle of rapidly boiling salted water, to which may be added one-fourth of a level teaspoonful of soda. (The soda aids in softening the woody fibre.) The kettle should be skimmed occasionally while the vegetable is cooking, or, to save trouble, some prefer tying the cauliflower in a thin cloth. An agate or porcelain lined kettle is preferable to iron, which is likely to discolor the cauliflower.

The odor is less noticeable if the kettle is left uncovered. The water may also be changed to dispel the odor. A cauliflower should be tender after twenty to thirty minutes of rapid boiling. If overcooked it appears soggy and water-logged.

A good cauliflower, well cooked, requires little additional flavor beside salt and good butter. Some, however, prefer the addition of grated cheese. The cauliflower may also be served as a garnish for meats, in sauces, soups and is excellent cold as a salad. Many prefer it with a thick cream sauce.

"Cold boiled cauliflower is very good fried plain in butter, or breaded and fried, or mashed and fried like oyster plant, with the addition of an egg and a palatable seasoning of salt and pepper."

The last paragraph is from Miss Carson's Practical American Cookery. Many other hints may be obtained from this and other leading guides to cookery.

2. *Culture*: In a general way the culture is the same as for cabbages. Early varieties should be started in the house or hot-bed as soon as the first of April. Handle as needed, and set in the open field as early as possible. The best soil is a rich, moist loam, but it should be well drained. Like the cabbage, the cauliflower is a gross feeder and demands intense culture. If growth is stopped from any cause, the heads are likely to "button" or form small sections interspersed with leaves, worthless for market purposes. Frequent cultivation is necessary, and it is probable that in case of very dry weather about the time of heading, irrigation would be a profitable means of securing a crop for home use at least. When the heads are about three inches across, the outer leaves should be brought together and held in place by means of a piece of twine or raffia, that the heads may be well bleached.

3. *Influence of Early Treatment*: The relative influence of pot and of box culture of young plants was considered with reference to the number of heads produced: Seed was sown April 3d; the young plants were transferred to two and one-half inch pots April 24th; to four inch pots May 10th, and to the field May 29th. A duplicate lot was handled in boxes at the same dates. At the last handling in the house, May 10th, the leaf surface was reduced about one-half. A tabular view of the results is given below:

TABLE IV,

CAULIFLOWERS IN POTS AND BOXES.

VARIETY.	Number heads cut July 26.	Number heads cut August 3.	Number heads cut August 15.	Number heads cut August 28.	Total number heads.	Number of plants.	Per cent of plants forming heads.
Dwarf French, Half Early Dwarf French.							
Pots	1	4	1	0	6	13	**46.2**
Boxes	0	4	1	0	5	21	**23.8**
Gilt Edge (Thorburn).							
Pots	4	9	2	1	16	17	**94.5**
Boxes	2	7	2	1	12	16	**75.0**
Paris, Extra Early Paris.							
Pots	2	1	0	0	3	17	**17.6**
Boxes	0	0	2	1	3	17	**17.6**
London, Large Early London.							
Pots	0	0	1	10	11	20	**55.0**
Boxes	0	0	3	10	13	21	**61.9**

In two instances there was a difference of twenty per cent in favor of the plants grown in pots. One variety gave the same number of heads in each case but the plants from pots were two to three weeks earlier than the others. The fourth variety gave a slight difference, about seven per cent, in favor of the box treatment. Doubtless any benefit that might arise from handling plants in pots would lie in the fact that the plants are kept at a more uniform rate of growth.

Conclusion: Indications point to an increased percentage of marketable heads as a result of handling cauliflower plants in pots during early stages of growth.

4. *Effects of Trimming:* The value of reducing the amount of foliage at the time of removal to the field with reference to the heading of cauliflower, received some attention. The seed was sown April 3, the young plants were transferred to boxes April 24 and again May 10. All were removed to the field May 29, when the foliage of one lot was reduced by one-half while a duplicate lot was left without trimming.

The table shows the relative earliness and the per cent of heads formed.

TABLE V.

EFFECT OF TRIMMING CAULIFLOWERS.

VARIETY.	Number heads cut July 26.	Number heads cut August 3.	Number heads cut August 15.	Number heads cut August 28.	Number heads cut September 15.	Total number heads.	Number of plants.	Per cent. of plants forming heads.
ALABASTER.								
Trimmed	3	4	1	2	-	10	12	**83.3**
Not trimmed	4	5	2	-	-	11	12	**91.7**
ERFURT (Large Early Dwarf).								
Trimmed	-	5	4	1	-	10	13	**76.9**
Not trimmed	-	7	3	1	-	11	13	**84.6**
ERFURT (Ordinary).								
Trimmed	-	4	7	6	-	17	19	**89.5**
Not trimmed	-	7	3	7	1	18	19	**94.7**
PRIZE EARLIEST.								
Trimmed	-	4	2	4	-	10	14	**71.4**
Not trimmed	-	-	5	4	-	9	13	**69.2**
STADTHOLDER.								
Trimmed	-	-	-	3	2	5	10	**50.0**
Not trimmed	-	-	-	3	-	3	9	**33.3**

As a rule, the per cent of heads formed was greater from plants not trimmed. There was practically no difference in the earliness of the two lots, nor was there a marked difference in the size of the heads.

Conclusion: Results obtained will not warrant us in commending the practice of trimming cauliflower plants severely at time of setting in the field.

5. *Varieties:* Nearly all of the more important varieties of cauliflower were grown in our gardens the past season for purposes of, comparison. We found, as was expected, a marked variation in different strains of the same type. The accompanying table will give a comprehensive view of the comparative merits of the different strains and varieties as regards earliness, percentage of heads formed, and average weight of heads. The latter quality is necessarily only relative; for a few days time, even after the head is ready for market makes a decided difference in weight.

TABLE VI.

VARIETIES OF CAULIFLOWER.

VARIETY.	Number heads cut July 26.	Number cut August 3.	Number cut August 15.	Number heads August 28.	Number heads September 15.	Number heads after October 1st.	Total number heads cut.	Number of plants.	Per cent of plants forming heads.	Average weight per head—lbs.
Autumn Giant	-	-	-	1	2	2	5	14	**85.7**	9.7
Best Early (Burpee's)	8	4	2	-	-	-	14	14	**100.0**	1.9
Dwarf Erfurt, extra early	3	3	5	1	-	-	12	12	**100.0**	2.8
Dwarf Erfurt, ordinary	-	7	3	7	1	-	18	19	**94.7**	3.7
Early Alabaster	4	5	2	-	-	-	11	12	**91.7**	1.3
Early Dwarf Danish	7	12	1	-	-	-	20	20	**100.0**	2.7
Early Paris	-	2	5	3	-	-	10	13	**76.9**	2.7
Early Asiatic	-	2	5	3	1	-	11	11	**100.0**	3.3
Early London	-	-	3	10	-	-	13	21	**61.9**	3.9
Extra Early Paris	-	-	2	1	-	-	3	17	**17.6**	0.9
Giant Purple, early	-	-	-	1	2	2	5	15	**33.3**	4.8
Giant Purple, late	-	-	-	1	2	1	4	16	**25.0**	7.9
Half Early Dwarf French	-	4	1	.	-	-	5	21	**23.8**	1.5
Imperial	1	6	2	1	-	-	10	11	**90.9**	2.6
Italian Taranto	-	-	-	1	3	-	4	22	**18.2**	6.9
Kronk's Perfection	7	5	3	1	-	-	16	16	**100.0**	2.2
Landrettis First	-	16	3	1	-	-	20	20	**100.0**	3.3
Large Late Dutch	-	-	-	2	1	-	3	24	**12.5**	6.0
Large Algiers	-	-	4	3	-	-	7	14	**50.0**	2.0
Large Early Dwarf Erfurt	-	7	3	1	-	-	11	13	**84.6**	2.0
Lenormand's Short Stem	1	-	4	1	-	-	6	18	**33.3**	1.1
Livingston's Earliest	8	4	1	1	-	-	14	18	**77.8**	3.2
Long Island Beauty	-	8	7	-	-	-	15	15	**100.0**	2.3
Nonpareil	-	-	4	5	1	-	10	15	**66.7**	3.0
Prize Earliest	-	-	5	4	-	-	9	13	**69.2**	3.2
Stadtholder	-	-	-	3	-	-	3	9	**33.3**	5.0
Thorburn Early Snowball	2	4	2	3	-	-	11	14	**78.6**	2.2
Thorburn Gilt Edge	2	7	2	1	-	-	12	16	**75.0**	0.6
Vaughan's Danish Snowball	2	7	2	1	-	-	12	12	**100.0**	
Walcheren	-	-	-	2	-	-	2	10	**20.0**	2.6

As will be seen, nearly all of the earliest varieties produced a high percentage of marketable heads, while the later sorts were anything but satisfactory. Of the whole number of varieties grown sixteen produced more than seventy-five per cent of marketable heads, while with eight varieties, every plant produced a good head. The earliest varieties were Burpee's Best Early, Dwarf Danish, Kronk's Perfection, and Livingston's Earliest. These were closely followed by Alabaster, Landreth's First, Long Island Beauty and several strains of Snowball.

Most of the late varieties were checked by the dry weather and showed a tendency to "button," or go to seed, hence are not considered here.

The following field notes concerning the more important varieties were made

Alabaster: (Johnson & Stokes).—Said to be a sport from *Dwarf Erfurt* (see below). A small early variety. An erect grower and may be planted closely.

Autumn Giant: (Thorburn).—A very large late variety of excellent quality; should not be started so early as most other sorts.

Best Early: (*Burpee's Best Early*, Burpee).—Small, but one of the earliest and surest heading varieties.

Dwarf Erfurt: (Thorburn).—Takes its name from the city of Erfurt, Germany, where cauliflowers are extensively grown. One of the most popular early varieties Several strains were grown this year, of which the best seemed to be Thorburn's Extra Early.

Early Danish: (Farquhar).—Of the Erfurt type; forming a medium sized head, very firm and good. One of the best.

Early Paris (Thorburn, Farquhar).—Moderately vigorous, with long stem and of spreading habit. Leaves covered with heavy bluish white bloom giving the variety a characteristic light shade. Heads of fair size but lacking in solidity.

Giant Purple. (Childs).—A large, late variety, very attractive when growing, and of excellent flavor, but when served its color is objectionable.

Imperial. (Landreth).—A medium sized pure white variety. Of spreading habit and heads not very firm.

Kronk's Perfection. (Farquhar).—A very fine strain of the Erfurt type. Of medium size, early, uniform, and in our plantation was among the best.

Landreth First. (Landreth).—Of vigorous, erect habit, but having a short stem. Heads of medium size, very solid, white, and rather remarkable for uniformity. One of the best.

Livingston's Earliest. (Livingston) —One of the earliest, small but uniform in date of maturity, a valuable consideration in a market variety.

Long Island Beauty. (Gregory) —A valuable second early sort. Only two cuttings were necessary and every plant produced a marketable head.

Prize Earliest. (Maule).—Three weeks later than some of the other varieties. Not satisfactory this season

Snowball. (*Early Snowball*, Thorburn).—A moderately vigorous variety forming small but very solid heads. From this type many valuable strains have been derived. One of the most valuable of these is the next mentioned.

Thorburn Gilt Edge. (Thorburn) —This variety is not quite so vigorous as the parent, the leaves are slightly smaller and very dense, while the stem is shorter. Heads small but handsome, and usually one of the most reliable.

Vaughan's Danish Snowball. (Vaughan) —Differs little in habit from Snowball described above. Very early and apparently a sure header.

London, Italian Taranto, Late Dutch, Algiers, Nonpariel, Stadtholder and some others while producing very good individual heads, were not reliable, the present season, and notes concerning these are withheld until further trial.

SUMMARY.

1. The general treatment of the cauliflower is similar to that required by cabbages. Thorough and frequent cultivation are essential.
2. Handling plants in pots before setting in the field increased the percentage of marketable heads.
3. Trimming plants at time of setting is of doubtful value.
4. Early varieties are, as a rule, more certain to produce a satisfactory crop than are the late sorts.
5. The earliest varieties grown the past season were: Burpee's Best Early, Dwarf Danish, Kronk's Perfection and Livingston's Earliest; closely followed by Alabaster, Landreth's First, Long Island Beauty and several strains of Snowball. All of these produced a high percentage of marketable heads.

III—NOTES OF TOMATOES.

As heretofore, special attention was given to methods of culture rather than to a multiplicity of varieties. Many of the experiments undertaken last season were repeated, for as before stated, positive conclusions can not be drawn from a single season's work.

1. *Effects of Early Setting*: A dozen plants of each of three varieties were used in the test. All were given similar treatment in the house. The first lot was removed to the field May 23d. The other a week later Owing to a heavy frost on the night of May 27th the early set plants were severely checked; while the weather for some days was cold and raw, but very dry. In spite of this check the first lot recuperated and by the first of October there was practically no difference in the two lots.

Table VII gives an exact statement of the results:

TABLE VII.

EFFECT OF EARLY SETTING.

VARIETY.	Date of first ripe fruit.	Average number fruits per plant.	Average weight of fruit per plant—pounds.	Average weight of individual fruits—ounces.	Number fruits per plant before October 1st.	Number decayed fruits per plant before October 1st.	Total number decayed fruit per plant.
BUCKEYE STATE.							
First setting....	Aug. 9..	11.0	6.4	9.3	6.4	1.3	5.8
Second setting	Aug. 10..	8.6	5.3	10.0	5.7	2.0	4.5
BURPEE'S CLIMAX.							
First setting..........	Aug. 4..	27.3	8.4	4.9	19.8	1.4	7.3
Second setting	Aug. 2..	33.6	10.4	4.9	20.8	1.2	10.6
GREAT B. B.........							
First setting	Aug. 27..	23.9	8.6	5.8	13.9	1.3	9.8
Second setting...	July 27..	29.5	11.0	6.0	13.4	1.9	15.5

There was very little difference in the time of ripening of the first fruits; and on the first of October, a date as late as can usually be relied on for tomatoes, there was practically no difference in the number of fruits produced by the two lots. The slight variation found was in favor of the early set plants.

As will be see by the last two columns in the table, the number of decayed fruits was very greatly increased late in the season, amounting in some cases to 75 per cent. of the fruit gathered.

Conclusion: While not so marked as in previous trials, indications still point to the value of early setting of tomato plants.

2. *Value of Pot-Culture*: The importance of careful handling of tomato plants has been emphasized in previous reports, and a limited amount of work has been done in this direction at this station.

During the past season a test of the relative value of pot-culture during the early stages of growth was conducted on lines similar to those detailed on page 102 for cabbage plants. A dozen plants of each of four varieties were transferred from the seed-flats to thumb-pots on April 27th, to three-inch pots May 9th. to four-inch pots May 20th, and to the open ground June 1st A duplicate lot was handled in flats at the same time. The results are shown in table VIII.

TABLE VIII.

VALUE OF POT CULTURE OF TOMATOES.

VARIETY.	Average number fruit per plant.	Average weight of fruit per plant—pounds.	Average weight of individual fruits—ounces.	Average number fruits per plant before October 1st.	Ratio (by number of fruit.)	Bushels per acre, before October 1st.
IGNOTUM.						
Pots	19.0	8.9	7.5	**10.5**	**1.28**	**139.4**
Boxes	12.3	5.9	7.7	**8.2**	**1.00**	**110.3**
ITHACA.						
Pots	23.5	6.7	4.6	**15.8**	**1.42**	**127.8**
Boxes	15.5	4.7	4.0	**11.1**	**1.00**	**98.7**
OPTIMUS.						
Pots	32.0	7.9	3.9	**14.2**	**1.21**	**112.1**
Boxes	16.5	4.3	4.2	**11.7**	**1.00**	**83.0**
STONE.						
Pots	14.3	5.5	6.2	**7.4**	**1.39**	**72.6**
Boxes	9.1	5.1	8.2	**5.3**	**1.00**	**81.3**

In every instance there was a marked increase in the number of fruits from plants handled in pots, and in the total weight of fruit produced. It will be observed, however, that the individual fruits averaged larger on the plants from boxes. This fact is no doubt due to the smaller numbers borne, as before mentioned.

In the last column is given the number of bushels per acre before October 1st, on the basis of the weight of fruit picked at that time, and considering the plants placed five feet apart each way in the field. With one variety the difference is slightly (about 9 bushels per acre) in favor of the box culture. This difference being due to the marked increase in size. But the first three varieties show a difference of more than 29 bushels each, in favor of the pot-grown plants. This difference, at 75 cents per bushel (none of our fruit was sold at less than 60 cents per bushel, and early in the season we received $1.75 at wholesale), would amount to $21.83 per acre, —a sum that would far more than pay for the cost of pots and the slightly increased cost of handling in the house.

Conclusion: There appears to be a marked increase in the productiveness of plants handled in pots previous to setting in the field.

3. *Individual Variation*: The danger from drawing too free conclusions from a single season's work was suggested last year, when it was found that, "In no case were the results from duplicate tests uniform."* A similar test of the variation of duplicate lots of any given variety was conducted the past season. The results bear out our former conclusion to such an extent that results of certain methods of culture undertaken are withheld for further verification.

Table IX shows the comparative results obtained with duplicate lots of each of three varieties, all of which were given the same treatment in house and field.

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*Report Maine Experiment Station, 1892, page 64.

TABLE IX.

INDIVIDUAL VARIATION.

VARIETY.	Average number fruits per plant.	Average weight of fruit per plant—lbs.	Average weight of individual fruits—ounces.	Average number decayed fruits per plant.	Date of first ripe fruit.
GOLDEN QUEEN	**13.9**	4.5	**5.2**	4.9	August 2.
	19.0	6.6	**5.5**	5.3	August 9.
ROSE PEACH	**16.6**	3.2	**3.1**	2.3	August 7.
	13.1	2.4	**3.0**	2.7	August 7.
ROYAL RED	**14.4**	5.6	**6.2**	6.3	August 7.
	15.0	5.8	**6.1**	6.7	August 4.

The weight of individual fruits was practically uniform, but the variation in number of fruits and in the consequent weight of the product was very marked. The date of ripening was also variable.

Conclusion : The individual variation of plants of any given sort is often such as to obscure any effects of different methods of culture. Results previously obtained are confirmed.

4. *Crossing* : Some of our work in developing a tomato which shall be of sufficient earliness to be profitable as a market crop in those sections where the seasons are short, was detailed in our last annual report.* Selections and further crosses were made the present season with interesting and promising results.

The *Lorillard-Peach* cross showed a less marked increase over the pure Lorillard, in number of fruits than was the case in the first generation,—a fact which illustrates the principle frequently laid down that crossing within the limits of the species tends to promote fruitfulness. In the second generation the influence of the male parent on the character of the fruit was shown by several individuals which assumed the peculiar rough skin, and to a certain extent the form of Peach.

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*Report Maine Experiment Station, 1892, p. 65.

The *Ignotum-Peach* cross showed a similar falling off in the second generation, as shown below.

IGNOTUM X PEACH.	Average number fruits per plant (both ripe and green.)	Average weight of fruit per plant—pounds.	Average weight of individual fruits—ounces.	Average number fruits ripened.
First generation	**191**	30.3	2.5	61
Second generation	**107**	17.4	2.6	35

As will be seen there is a falling off of nearly forty-four per cent in the total number of fruits borne. It is however quite possible that the conditions under which the parents were grown in the two generations may account for some of this variation.

The original parent was grown in the house and was specially cared for. The plants from which the "second generation" in this trial came, were given ordinary field culture, though the ground was rich and the plants were well cared for.

We know that conditions of growth during a single generation, exert a marked effect on the vitality of seeds. This influence, extending further in the life history of the plant, may determine to a certain extent the character of any strain. In this way it would seem possible that by forcing plants to early development in the house and by limiting the amount of fruit borne for a few generations, a strain of unusual vigor may be produced. This question is receiving attention in our houses at the present time.

The result obtained from crossing the *Lorillard-Currant* hybrid described in our last report,* with the female parent—Lorillard—promises valuable results. Naturally the number of fruits is reduced, but the size is fully doubled, while the quality is much improved.

5. *Varieties*: The tomatoes were started in the forcing house March 27th. All varieties were given the same treatment while in the house and were transferred to the open field June 1st. The first ripe fruits were found July 25th, on Golden Ball and Long Keeper. Two days later one or more fruits were gathered from Aristocrat, Great B. B., Ithaca and Maule's Earliest.

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*Report Maine Experiment Station, 1892, page 68.

On October 1st, when the season was practically ended, the fol- owing varieties were found in the order named, to have been the nost productive: Golden Ball, Improved Peach, Maule's Earliest, urpee's Climax, Lorillard, Ithaca and Belmont. Optimus, which as the most productive sort grown last year stood *ninth* (or drop- ing the first two varieties which are of value for amateur culture nly, *seventh*) in the list the present season.

The large late varieties, such as Belmont, Buckeye State and tone. decayed very badly late in the season. The same is true o a certain extent of Ignotum, Matchless and Optimus.

Maule's Earliest and Burpee's Climax were both much smoother han is usual with very early sorts, and are promising.

Ithaca and Long Keeper deserve the credit given in previous eports.

Lemon Blush failed to blush and was consequently inferior to olden Queen.

Buckeye State, Royal Red and Stone, while of merit as individ- al fruits, are all too late for our short seasons. Ponderosa will e discarded for similar reasons.

Terra Cotta was of very unsatisfactory quality, and is not a rmly fixed variety.

Great B. B., in spite of its name is a fairly good variety. It ecayed badly late in the season.

SUMMARY.

1 The conclusions of former years as to the value of setting omato plants as early in the spring as possible are confirmed.

2. Plants handled in pots previous to setting in the field are nore vigorous and productive than those not so handled,—a fact hich may be of great importance to the commercial grower.

3. Individual variation is often such as to render the work of ny one season unreliable.

4. The productiveness of any given variety may be largely ncreased by crossing with some of the smaller less valuable sorts. ut this increased productiveness may be partially or wholly lost n a few years even if good culture is given. The variety will uickly "run out."

5. It seems possible that seeds from plants grown under high ulture in the house may give better results than those from plants ot so treated.

6. By combining the Lorillard-Currant hybrid, with the Lorillard, the size has been more than doubled, and the quality is much improved.

7. Of the newer varieties, Burpee's Climax, Maule's Earliest and "B. B." were among the most promising. Buckeye State, Ponderosa, Royal Red and Stone are too late for our climate. Lemon Blush lacked its distinguishing characteristic, and Terra Cotta was of inferior quality.

IV—Notes of Egg Plants.

Our work with egg plants during the past season has been principally confined to methods of culture, including time of setting; deep and surface cultivation; the value of frequent cultivation, the effect of root pruning. In all cases seed was sown March 17. The young plants were pricked out into seed flats April 28; transferred to 4-inch pots May 22, and with the exception of one lot, to the open field June 10.

1. *Value of Early Setting*: The egg plant, being of tropical origin, is very sensitive to sudden changes of temperature. The question has therefore arisen: Will not plants give more satisfactory results if allowed to remain in the house till the season is well advanced, provided they are not checked or crowded?

The writer has usually advocated setting plants about the 10th to the 15th of June, but as bearing upon this point two lots of each of three varieties were given similar treatment during the season, save that one lot was set in the field June 10, and the other June 21, the season being unusually late. The comparative results are shown in table X.

TABLE X.

EARLY *vs.* LATE SETTING OF EGG PLANTS.

VARIETY.	Number of plants.	Number of plants bearing marketable fruits.	Number of marketable fruit.	Per cent of plants bearing marketable fruit.
EARLY DWARF PURPLE.				
Early set	18	18	**40**	**100.0**
Late set	15	13	**15**	**86.7**
EARLY LONG PURPLE.				
Early set	17	12	**30**	**70.6**
Late set	16	10	**17**	**62.5**
BLACK PEKIN.				
Early set	18	18	**21**	**100.0**
Late set	17	11	**12**	**64.7**

It will be observed that in every instance the lot set June 10, produced a larger percentage of plants bearing marketable fruits than did the lot set later. This difference in one case—Black Pekin—amounted to more than 35 per cent. The average number of marketable fruits on the bearing plants was also much larger from those set early. Dwarf Purple produced nearly twice as many fruits from the first lot as from the others.

This difference is due to two causes. Fruits seem to set more freely in the warm days of July and August—hence the desirability of having the plants in full vigorous growth at that time; while the fruits formed later are almost certain to be injured by frost before reaching edible maturity.

Conclusion: The percentage of plants bearing marketable fruits, also the productiveness of individual plants, is considerably less from plants set late in June than from those set earlier.

2. *Deep vs. Shallow Cultivation*: We have always recommended constant cultivation as one of the first requisites to success with egg plants. There is a question, however, whether it is advisable to disturb the roots to so great a depth as is commonly done with the ordinary farm cultivator. As bearing upon this point a

number of plants of each of three varieties were given ordinary deep cultivation, while a duplicate lot, planted by the side of the first was given very shallow cultivation. The first lot was cultivated about once in ten days with a Planet Jr. horse hoe; the second was hoed by hand at the same time.

The results obtained are shown in table XI.

TABLE XI.

DEEP *vs.* SHALLOW CULTIVATION OF EGG PLANTS.

VARIETY.	Number of plants.	Number of plants bearing marketable fruit.	Number marketable fruits.	Per cent of plants bearing marketable fruit.
ROUND WHITE.				
Deep	11	10	17	**90.9**
Shallow	15	10	14	**66.7**
CREOLE.				
Deep	13	7	9	**53.8**
Shallow	12	2	2	**16.7**
NEW YORK IMPROVED.				
Deep	14	5	5	**35.7**
Shallow	15	6	7	**46.7**

As will be observed Creole and Round White were much more productive when deep cultivation was practiced. New York Improved was very unproductive in both cases, but the plants given surface cultivation were slightly the more productive. The season was very dry and it is probable the chief advantage of the deep cultivation was in driving the feeding roots downward, the lose earth above forming a mulch.

Conclusion: Better effects appear to result from the deep cultivation of egg plants with the horse hoe than from shallow hand work.

3. *Is Frequent Cultivation Essential?* The writer has usually advised cultivating egg plants as often as once a week. And is often met by the farmer with the objection of "too much bother." An attempt was made the present season to determine if frequent

cultivation really is essential to success. Some plants were given the ordinary treatment of our garden, while a duplicate lot was given only sufficient attention to keep down the weeds. Unfortunately the varieties used—New York Improved and Round Purple—proved so unproductive that we are not justified in drawing final conclusions. In this instance, however, the plants given infrequent cultivation produced fully as many fruits as those under conditions usually regarded as more favorable. If it be proved that the egg plant may be grown with less care than commonly supposed, the fact, though of no importance to the gardener, may serve to remove some objections to the more common use of this vegetable.

4. *Effects of Root Pruning*: To ascertain whether a sudden check in the growth of the plants would result in increasing the number of fruits set, several of the main roots of a number of plants were severed August 19, after a small number of fruits had formed. Results were contradictory. Some varieties showed considerable increase in the number of fruits set, as compared with duplicate plants not pruned; others were apparently injured by the operation. The advantage of the operation from a practical point of view is questionable.

SUMMARY.

1. The percentage of plants bearing marketable fruits, and the productiveness of individual plants, are increased by early setting in the field.
2. Better results are obtained from deep cultivation with the horse hoe than from shallow hand work.
3. Early dwarf varieties may be successfully grown with the ordinary care given tomato plants.
4. The advantage of root pruning egg plants is questionable.

V—NOTES OF POTATOES.

The principal work heretofore undertaken with potatoes has been in the line of a study of the influence of climate in causing variation of the plant—an experiment still in progress. During the past season a few experiments with different methods of culture were taken up incidentally.

1. *A comparison of the Trench System with Ordinary Culture*: A few years ago considerable interest was aroused by the accounts of wonderful yields of potatoes obtained by a system of culture

known as the *Rural New Yorker Trench System.* The system derives its name from the fact that it was first used at the trial grounds of the *Rural New Yorker*, and was advocated by the editor of that paper, Mr. E. S. Carman.

The system consists essentially in planting the tubers in trenches, five to seven inches deep and twelve to fifteen inches wide, the bottoms of which are well pulverized; covering to a depth of about two inches; then applying any desired amount of fertilizer in the trench; after which the trenches are filled so that after settling the surface shall be level.

Now it has been the practice of the writer for several years to plant in furrows, applying fertilizers broadcast on the surface of the ground, for there is little doubt that the old custom of "hilling" potatoes is worse than useless, it is positively injurious to the crop on dry soils It has seemed doubtful, in view of the fact that the roots of the potato extend in all directions, filling the whole space between the rows, whether placing the fertilizer in a trench only, could be as rational, or in practice as satisfactory, as the other method.

In the paper referred to and also in a book recently published, the statement is made that, "In every trial made the land laid out in trenches whether with or without fertilizer or manure has largely out-yielded that planted according to the old method of furrows or hills."*

In an issue of the *Rural New Yorker* of recent date is a detailed account of a comparison of the two methods as conducted on the grounds of the originator of the "Trench system." From this trial the following conclusions were drawn:

"There is a difference in the total yield per acre of only one-half bushel (.49) in favor of the trenches, but of the *marketable* potatoes there is a difference of over seventeen bushels per acre in favor of the trenches.

"The yield of small potatoes (unmarketable) of the furrows is 16.79 bushels per acre greater than that of the trenches."†

The work of this Station planned without the knowledge that similar work was being undertaken elsewhere, is detailed below:

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* The New Potato Culture, page 35.

† Rural New Yorker, October 14, 1893, page 683.

On a piece of sandy loam, having a Southern aspect, alternate rows of the varieties named below were planted three and one-half feet apart—one being "trenched," the other planted in a furrow. The rows "trenched" were plowed about a foot wide and eight inches deep, after which the soil in the bottom of the furrow was loosened and pulverized, some earth being worked back into the furrow, the "seed" cut into two eyes was then planted one foot apart in the row. The pieces were covered to a depth of about two inches when a complete fertilizer at the rate of 1,000 pounds to the acre was scattered in the trenches, and the trenches were filled. The other rows were simply plowed, the seed pieces dropped and covered, when the same amount of fertilizer as before was scattered on the surface. As soon as the young shoots appeared above the surface, the smoothing harrow was used, and thorough culture was given until about the middle of July when the vines covered the ground sufficiently to keep the weeds down and serve as a mulch for themselves.

The comparative results are shown in the accompanying table:

TABLE XII.

TRENCH SYSTEM *vs.* ORDINARY CULTURE OF POTATOES.

VARIETY AND SYSTEM.	Weight of product—lbs.	Weight of marketable tubers—lbs.	Weight of small tubers—lbs.	Average number marketable tubers per hill.	Yield per acre of marketable tubers—bushels.	Yield per acre of small tubers—bushels.
EARLY ROSE.						
No 1. Furrow	58.87	51.03	7.84	**5.6**	**234.4**	**34.6**
Trench	61.48	53.24	8.24	**5.0**	**244.5**	**37.9**
No. 2. Furrow	80.00	71.00	9.00	**6.9**	**327.7**	**41.5**
Trench	79.23	68.72	10.51	**6.1**	**317.4**	**48.5**
CRANE'S JUNE.						
No. 1. Furrow	69.90	62.00	7.90	**6.0**	**286.2**	**36.3**
Trench	66.30	54.81	11.49	**5.2**	**253.1**	**52.9**
No. 2. Furrow	70.19	58.45	11.74	**5.9**	**269.6**	**54.1**
Trench	71.57	61.04	10.53	**5.8**	**282.1**	**48.5**
HEBRON.						
Furrow	64.15	59.12	5.03	**5.4**	**271.7**	**23.2**
Trench	74.07	65.16	8.91	**5.4**	**300.8**	**41.1**

In every instance duplicate lots produced contradictory results. The first lot of Early Rose gave a greater yield from the trench—the difference being nearly ten bushels of marketable tubers per acre. The second lot reverses these figures so far as the marketable tubers are concerned, but the increased numbers of small tubers makes the total yield practically the same with the two methods of treatment. The first lot of Crane's June gave a difference of thirty-three bushels of marketable tubers per acre in favor of the furrow; while in the second lot the trench produced at the rate of twelve bushels per acre more than the other.

In each instance above mentioned, the number of marketable tubers per hill was slightly smaller in the trenches, and the weight of individual tubers was somewhat greater; on the other hand, with one exception the small tubers from the trenches excelled in weight and number those from the furrows.

Hebron from the trench was superior to the same variety from the furrow. The number of tubers per hill was the same, but the individual tubers from the trench were so much superior as to be equivalent to an excess of twenty-nine bushels per acre over the other.

It will be seen that these facts are in a measure opposed to conclusions concerning the system which have heretofore been published. We would not, however, condemn the method without further trial. It is but just to say, however, that certain parties quoted as obtaining specially marked results from the use of the "trench system" have discarded the method in their general practice.

Conclusion: It is questionable whether the results obtained will justify the extra labor involved in practicing the trench system of potato culture. In our trials the past season duplicate lots in every instance produced contradictory results.

VI—NOTES OF SPRAYING EXPERIMENTS.

Spraying with some solution of copper for protection from the attack of the apple scab is coming to be looked upon as a necessity by many of the more progressive orchardists. During the past three seasons the writer has been engaged in solving some of the problems incident to this work. The results, so far as obtained, have been detailed in the annual reports of the experiment station.*

The principal work of the present season was a comparison of the effectiveness of different mixtures. The failure of certain trees, set apart for that purpose, prevented reaching more definite conclusions regarding the best time for spraying

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* Report Maine Experiment Station, 1891, page 112; and 1892, page 92.

The materials used in the work here mentioned, were as follows:

1st.—*Modified eau celeste.*—2 lbs. copper sulphate, 1 1-2 lbs. carbonate of soda, 1 1-2 pts ammonia and thirty-five gallons of water.

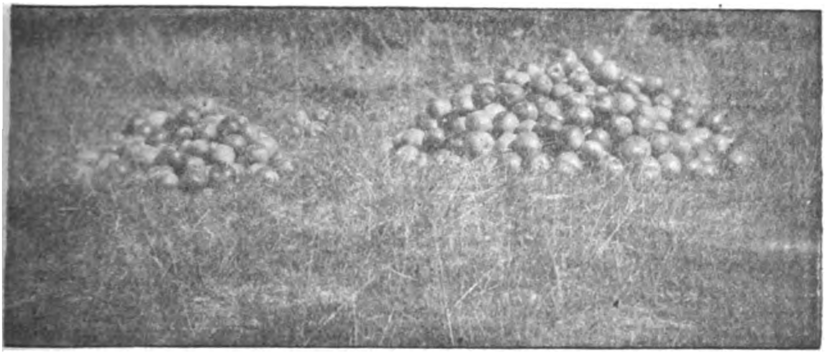
2nd.—*Bordeaux Mixture.*—6 lbs. copper sulphate (Blue Stone), 4 lbs. fresh lime dissolved separately, then mixed and diluted to 40 gallons.

3d.—*Bordeax Mixture and Paris Green.*—Same as No 2 with addition of Paris Green in the proportion of 1 lb to 150 gallons.

4th.—*Paris Green* —1 lb. Paris green in 250 gallons water.

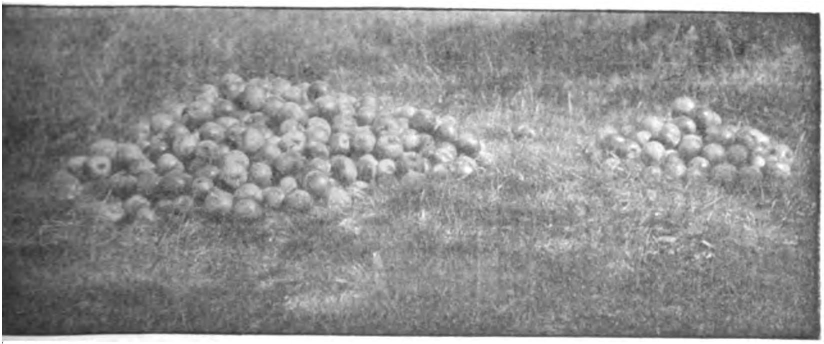
The season was very dry and the trees were much freer from scab than in previous years. That there was marked benefit from the treatment is, however, shown in the accompanying photographs of fruit from contiguous trees and also in the table.

No. 1—Not Sprayed.



Free, 130. Badly Scabbed, 17. Slightly Scabbed, 392.

No. 2—Sprayed.



Free, 474. Badly Scabbed, 3. Slightly Scabbed, 114.

TABLE XIII.

RESULTS OF SPRAYING TO PREVENT APPLE SCAB.

TREATMENT.	Number fruit examined.	Free from scab.	Slightly scabbed.	Badly scabbed.	Per cent free.
EAU CELESTE	651	480	156	15	73.7
	557	360	189	8	64.6
	459	368	73	18	80.2
Average per tree	**556**	**403**	**139**	**14**	**72.5**
BORDEAUX MIXTURE	501	399	91	11	79.6
	591	474	114	3	80.2
Average per tree	**546**	**436**	**102**	**7**	**79.9**
BORDEUAX MIXTURE AND PARIS GREEN	811	677	128	6	83.5
	639	509	126	4	79.7
	615	524	87	4	85.2
Average per tree	**755**	**570**	**114**	**5**	**82.5**
CHECKS, NOT SPRAYED	566	214	337	15	37.8
	550	291	248	11	52.9
	539	130	392	17	24.1
Average per tree	**552**	**212**	**292**	**14**	**38.3**

Much of the fruit classed as "slightly scabbed" would grade as No. 1 fruit, but as is well known, the fungus grows rapidly after the fruits are packed ; hence our arbitrary line between fruit *absolutely free* from scab and that slightly affected is rigidly adhered to.

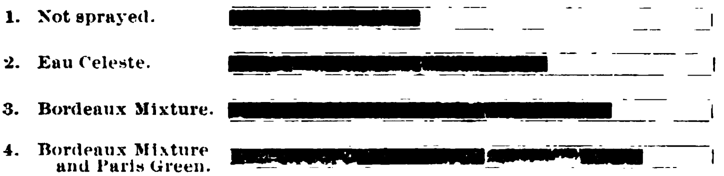
As shown by the table, the best results were obtained from the use of a combination of Bordeaux mixture and Paris green. This fact would indicate a possible fungicidal value for Paris green. That this value is slight, however, was shown by some trees sprayed with Paris green only. Our experiments have not been sufficiently extended to warrant definite conclusions on this point. The Paris green has, however, an important use in reducing the proportion of wormy fruits.

Eau Celeste, while less effectual than Bordeaux mixture in preventing scab, was found to injure the foliage unless used with caution. The fruit also, was made somewhat rusty—the epidermis apparently being injured by the ammonia.

The relative value of the different materials used may best be summarized as follows:

Checks, not sprayed..	38.3	per cent free from scab.
Modified *Eau Celeste*	72.8	" " " "
Bordeaux mixture...	79 9	" " " "
Bordeaux mixture and Paris green,	82 8	" " " "

These differences are graphically portrayed in the accompanying diagram, in which the shaded portion represents the per cent of fruit free from scab.



The concensus of opinion among experimenters at the present time places Bordeaux mixture at the head of the list of fungicides. A general summary of results obtained by the writer during the past three seasons is as follows, the figures representing the per cent. of fruit free from scab:

SPRAYING EXPERIMENTS, 1891-93.

	Checks not sprayed.	Ammonio copper carbonate.	Modified eau celeste.	Bordeaux mixture.
1891	4.1	47.8	57.8	
1892	.98	6.1	30.1	
1893	38.3	-	72.8	79.9

A BRIEF RETROSPECT.

For the benefit of those who have not received previous reports, it may be well to give a brief resumé of the results obtained from three seasons' experiments.

We have seen that apple scab is caused by a parasitic fungus which attacks the leaves and young twigs as well as the fruit, and that the growth of the tree may be seriously checked. Spraying the trees with certain compounds of copper has been found an effective means of holding the disease in check.—the increase of salable fruit, as a result of spraying, often amounting to 50 per cent.

Indications point strongly to the value of spraying early in the season, before the blossoms open, and of repeating the application four or five times during the season.

The best results have been obtained from the use of Bordeaux mixture, prepared as follows: 6 pounds copper sulphate (Blue Stone); 4 pounds quick lime; 40 gallons water.

Dissolve the copper in a pail of hot water; slake the lime in another vessel; mix and dilute as above for use.

Farmers are advised to club together in the purchase of apparatus and chemicals, thus reducing expense.

Necessary chemicals may be obtained in large quantities of: Weeks & Potter Company, Boston; Eimer & Amend, 205 Third Avenue, New York; W. S. Powell & Company, Baltimore, Md. Most of the materials may be purchased in small amounts at the local drug store.

Force pumps and other apparatus for spraying may be obtained of any of the leading manufacturers, as: Field Force Pump Company, Lockport, N. Y.; Gould's Manufacturing Company, Seneca Falls, N. Y.; W. & B. Douglass, Middletown, Conn.; The Deming Company, Salem, O.

The most satisfactory nozzle we have used is the "McGowen," manufactured by John J. McGowen, Ithaca, N. Y. Our second choice is the "Climax." manufactured by the Nixon Nozzle and Machine Company, Dayton, O.

For spraying currant bushes, or for general garden use, the "Knapsack Sprayer" made by the Gould's Manufacturing Company, Seneca Falls, N. Y., has been found very satisfactory. Similar machines may be obtained from the other sources mentioned above.

VII—Catalogue of Maine Fruits.

One of the most important lines of work receiving attention from this division is that of the systematic effort to improve the character of some of our native fruits, and to select from the ever increasing list of new varieties, those best suited for the different sections of the state. This work is still in its infancy and no results can yet be reported. It is thought best, however, to publish a catalogue of the fruits grown in the state at the present time with an indication of their approximate value in different sections.

The descriptions of fruits are mostly taken from the fruit list of the American Pomological Society, and the values accorded are given only after carefully considering the recommendations of leading fruit growers in different parts of the State. Information concerning many varieties, especially in the northern sections is very meagre. It is hoped before a revision of the list is made,—as will necessarily follow in course of two or three years,—more valuable data may be available.

Of the newer apples named in the catalogue, Dudley's Winter, a seedling of Oldenburg originated by J. W. Dudley of Castle Hill, Aroostook county, is one of the most valuable "iron clad" varieties. This variety is being disseminated by a New York firm as "North Star"—an unfortunate circumstance as there is another variety bearing that name by right of priority.

Hayford Sweet is another valuable iron-clad variety originating with C. Hayford, Maysville, Aroostook county. It is in itself a valuable fruit and succeeds where Talman Sweet fails.

Rolfe and Russell are also deserving of special mention. Mother, as a fruit for home use, is not as widely known as it should be; but it is not a profitable market variety.

Of the newer pears, Admiral Farragut, Eastern Belle, Fulton, Indian Queen and Nickerson are promising, hardy varieties. These are not of the highest quality but they are hardy and productive—important considerations especially for the northern and central portions of the state.

Flemish Beauty, formerly grown in many sections of the state, has been almost universally discarded because of the prevalence of pear scab (*Fusicladium pyrinum*). It is hoped that by the aid of the Bordeaux mixture we may yet retain this valuable variety.

Moore Arctic plum, (a native of Ashland, Aroostook county), because of its productiveness and extreme hardiness, is planted more extensively than any other variety in northern Maine. It is not, however, of the best quality. The Japanese varieties, Abundance and Burbank, are being tried to a limited extent in the southern portions of the state, but they can succeed only in the southern counties. McLaughlin, originated at Bangor more than forty years ago, is still one of our most valuable dessert plums. It is, however, rather tender for market purposes.

DeSoto, Forest Garden, Wolf, and some other varieties of the native "horse plum" or "pomegranate" (*Prunus Americana*), promise to be of some importance for the colder portions of the state.

Small fruits, though not largely grown for market, do well in all of the central and southern counties. The cool moist climate is specially adapted to the wants of the currant and gooseberry. Even as far north as Houlton, Aroostook county, the gooseberry is a profitable market crop; and if, as now seems probable, the English varieties will succeed in this climate, a very profitable industry is opened along this line.

The widely varying conditions existing in different parts of the state render a general statement as to the value of any given variety only approximately correct. Varieties which may be of merit in the southern portions of the state are not sufficiently hardy for the middle and northern counties. On the other hand, some sorts considered specially valuable in Aroostook county are unknown in York. In the accompanying catalogue we have assigned separate columns for the value of each variety in the northern and the southern parts of the state. The first column, marked "North," includes Aroostook, Piscataquis, and the northern parts of Somerset, Penobscot and Washington counties. The column marked "South," includes Oxford, Kennebec, Waldo, and all of the southern counties.

The value of any given variety is indicated thus: Two stars (* *) indicate a variety of special merit, one to be recommended for general culture. One star (*) shows that the variety is worthy of cultivation, though not superior. A dagger (†) indicates a new and promising variety, or an old variety not fully tested in this region. A dash (—) shows that the variety has been tried and found wanting.

The abbreviations used in describing the size*, form, color, etc., of the various classes of fruits are fully explained at the head of each list. Take for example the Alexander apple. We see that this is a large striped apple of roundish-conical form and moderately good quality, useful for cooking and market early in autumn.

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*A few varieties of apples usually described as large, are as grown in this state, of only medium size—e. g. Baldwin, Golden Sweet, Hubbardston, Porter.

APPLES.

ABBREVIATIONS USED.—*Size*,—l, large; m, medium; s, small. *Form*,—r c, roundish-conical; r ob, roundish-oblate; r, roundish. *Color*,—y r, yellow and red; r s, red striped; g y, greenish yellow; rus, russeted; y rus, yellow and russet. *Quality*,—g, good; v g, very good; b, best. *Use*,—F, family use; K M, kitchen and market; F M, family and market. *Season*,—S, summer; E A, early autumn; L A, late autumn; W, winter. *Origin*,—usual abbreviations for names of countries.

Number.	NAMES.	DESCRIPTION.							VALUE.	
		Size.	Form.	Color.	Quality.	Use.	Season.	Origin.	North.	South.
1	Alexander	l	r c	r s	g	K M	E A	Rus.	*	*
2	August								†	....
3	Autumn								†	....
4	Bailey Sweet	l	r c	r s	v g	F M	L A	Am.	..	*
5	Baldwin	l	r c	r g	v g	F M	W	Am.	—	**
6	Beauty of Kent	l	r c	r s	g	K M	L A	Eng.	....	*
7	Ben Davis	l	r c	y r	g	K M	W	Am.	—	**
8	Benoni	m	r ob	y r	v g	F M	S	Am.	....	*
9	Black Oxford								—	—
10	Bloom								†	....
11	Blue Pearmain	l	r c	r	g	M	W		—	*
12	Bullock, *American Golden Russett*	s	r c	y rus	b	F M	W	Am.	...	*
13	Canada Baldwin	m	ob	r	v g		W	Can.	....	*
14	Chenango (Strawberry), *Sherwood Favorite*	m	ob c	g r	v g	F M	E A	Am.	...	*
15	Cole Quince	l	r ob	g y	v g	F M	W	Am.	....	*
16	Colton								†	...
17	Cooper Market	m	r c	y r	g	M	W	Am.	...	*
18	Danvers Sweet, *Danvers Winter*	m	r ob	g y	v g	F M	W	Am.	....	*
19	Dudley Winter	m	r ob	y r	g	F M	W	Am.	**	*
20	Dyer, *Pomme Royal*	m	r	g y	v g	F	E A	F.	....	*
21	Early Harvest	m	r ob	g y	v g	F M	S	Am.	*	*
22	Early Scarlet								†	...
23	Early Strawberry *Red Juneating*	s	r	r s	v g	F	S	Am.	....	*
24	English Russett, *Poughkeepsie Russett*	m	r c	y rus	v g	F M	W	Eng.	....	—
25	Esopus Spitzenburg	l	ob	y r	b	F M	W	Am.	....	*
26	Fallawater	l	r c	g y	g	M	W	Am.	....	*
27	Fall Harvey	l	r ob	g y	g	M	L A	Am.	....	*
28	Fall Jenneting	l	fl	g y	g	M	E A	Am.	*	*
29	Fall Pippin	l	r ob	g y	v g	F M	L A	Am.	....	*
30	Fall Queen, *Haas, Gros Pommier*	m	ob c	y r	g	F M	A	Am.	—	—
31	Fameus, *Snow Apple*	m	r ob	r s	v g	F M	W	F.	**	**
32	Foundling	m	r ob	y r	g	F	A	Am.	*	*
33	Garden Royal	m	r c	y r	b	F	S	Am.	—	*
34	Garden Sweet	m	r ob	y r	v g	K M	A	Am.	...	*
35	Gideon								—	—
36	Golden Russet of Western N. Y	m	r ob	y rus	v g	F M	W		....	*
37	Golden Sweet	l	r	g y	v g	F M	S	Am.	....	*
38	Granite (Beauty)	l	r ob	y r	g	F M	W	Am.	....	**
39	Gravenstein	l	r ob	y r	v g	F M	L A	Ger.	—	**
40	Grimes Golden	m	r ob	g y	v g	F	W	Am.	—	*
41	Hayford Sweet	s	r c	y r	g	F M	W	Am.	**	*
42	High Top Sweet, *Sweet June*	s	r	g y	v g	F M	S	Am.	—	*
43	Hubbardston, *Hubbardston Nonesuch*	l	r c	y r	v g	F M	W	Am.	....	**

7, valuable for distant market; worthless for home use. 12, 24 and 36 are often confounded; 36 is the variety most commonly met. 26, handsome, but coarse and of inferior quality in this climate. 39, one of the most valuable autumn varieties.

Apples—Continued.

Number.	Names.	DESCRIPTION.							VALUE.	
		Size.	Form.	Color.	Quality.	Use.	Season.	Origin.	North.	South.
44	Hunt Russett	m	r ob	y rus	v g	F M	W	Am.	....	*
45	Hurlbut	m	r ob	y r	g	F M	L A	Am.	....	*
46	Jewett Red, *Jewett's Fine Red, Nodhead*	m	r ob	r	g	F M	W	Am.	....	**
47	Late Strawberry, *Autumn Strawberry*	m	r	y r	v g	F M	L A	Am.	....	*
48	Longfield	m	r ob	y r	g	K M	L A	Rus.	†	*
49	Magog Red Streak	...	....	......	.....	.....	.....	......	†	....
50	Maiden Blush	m	r	g y	g	K M	E A	Am.	....	*
51	Mann	m	r ob	y r	v g	F M	W	Am.	—	*
52	McIntosh	m	r ob	y r	v g	F M	W	Am.	....	*
53	Mexico	m	r ob	r s	v g	F M	A	Am.	....	†
54	Milden or Milding	l	fl	y r	v g	F M	E W	Am.	....	*
55	Minister	l	ob	r s	g	K M	L A	Am.	....	*
56	Monroe Sweet	....	......	......	.....	.....	.....	.....	†	....
57	Mother	m	r c	y r	b	F M	W	Am.	....	**
58	Munson Sweet, *Orange Sweet*	m	fl	y g	g	K M	L A	Am.	....	*
59	New Brunswick Greening	....	......	......	.....	.....	.....	......	†	....
60	Northern Spy	l	r c	y r	b	F M	W	Am.	—	**
61	Oldenburg, *Duchess of Oldenburg*	m	r ob	y r	g	M	S	Rus.	**	**
62	Peabody Greening	...	.. ..	......	.....	... .	.....	......	—	....
63	Peach (of Montreal)	m	r c	y s	v. g	F M	A	F.	*	....
64	Peck Pleasant	m	r	g y	v g	F M	W	Am.	...	*
65	Pewaukee	l	fl	r s	g	F M	W	Am.	*	*
66	Porter	l	ob	g y	b	F M	A	Am.	—	**
67	President	l	r ob	y	g	F	A	Am.	....	*
68	Primate	m	r c	g y	b	F	E A	Am.	...	*
69	Prolific Sweeting	.....	......	......	.....	.....	.....	......	†	....
70	Pumpkin Sweet, *Lyman's Pumpkin Sweet, Pound Sweet*	l	r ob l	y	g	K M	E W	Am.	....	*
71	Ramsdell Sweet	m	ob	y r	g	K M	L A	.....	....	**
72	Red Astrachan	l	r	y r	g	K M	S	F.	*	**
73	Red Beitigheimer	....	......	......	.....	.....	.....	......	†	†
74	Red Canada, *Old Nonesuch, Richfield Nonesuch, Steele's Red Winter*	m	r ob	y r	b	F M	W	......	†	*
75	Rhode Island Greening	l	r ob	g y	v g	F M	W	Am.	—	**
76	Ribston, *Ribston Pippin*	m	r	y r	v g	F M	W	Eng.	....	*
77	Rolfe, *Macomber*	m	r c	y r	v g	F M	W	Am.	—	**
78	Rome Beauty	l	r	y r	g	M	L A	Am.	....	†
79	Roxbury Russett	m	r ob	y rus	v g	F M	W	Am.	....	*
80	Russell	l	ob	y	v g	F	E A	Am.	†	†
81	Saint Johnsbury Sweet	....	......	......	.....	.....	.....	.. ...	†	....
82	Saint Lawrence	l	fl	y r	v g	M	A	......	†	*
83	Sarah	l	fl	r s	v g	F M	E A	Am.	.. .	†
84	Scott's Winter	....	......	......	.....	.....	.....	......	†	....
85	Somerset (of Maine)	m	fl	r s	v g	F	S	Am.	....	*
86	Sops of Wine, *Hominy*	m	r	y r	g	K M	E A	Eng.	—	*
87	Stark	l	r c	y r	g	F	W	Am.	...	*
88	Starkey	m	r ob	y r	v g	F M	E W	Am.	....	*
89	Summer Pearmain, *American Summer*	m	ob	y r	b	F	S	Am.	....	*
90	Summer Paradise	l	r	g y	v g	F	E A	Am.	....	*
91	Sutton, *Sutton Beauty*	m	r ob	r s	v g	F M	E W	Am.	....	†
92	Swaar	l	r ob	g y	b	F M	W	Am.	...	†
93	Sweet Bough, *Large Yellow Bough*	l	ob	g y	v g	F M	S	Am.	....	*
94	Sweet Janet	....	......	......	.....	.....	... .	......	....	†

Apples—Concluded.

Number.	Names.	Description.							Value.	
		Size.	Form.	Color.	Quality.	Use.	Season.	Origin.	North.	South.
95	Tetofsky	m	fl c	y r	g	K	S	Rus.	**	*
96	Talman Sweet	m	r	g y	v g	K M	W	Am.	**	—
97	Tompkins King, *King of Tompkins County*	l	r	y r	v g	F M	W	Am.	—	*
98	Twenty Ounce, *Cayuga Red Streak*	l	r	r s	v g	F M	L A	Am.	....	*
99	Wagener	m	r ob	y r	b	F	W	Am.	....	*
100	Walbridge	...	......	......	....	.....	.....	......	*	....
101	Washington (Strawberry)	l	r c	y r	v g	F M	E A	Am.	....	*
102	Wealthy	m	r ob	r	v g	F M	W	Am.	**	*
103	Westfield (Seek-no-further)	l	r c	y r	b	F M	W	Am.	....	*
104	Williams (Favorite)	m	r c	g y	g	M	S	Am.	—	**
105	Wine, *Hay's Wine, Pennsylvania Red Streak*	l	r	y r	v g	F M	W	Am.	...	*
106	Winesap	m	r	y r	v g	F M	W	Am.	....	*
107	Winthrop Greening	l	ob	g y	g	K M	A	Am.	....	*
108	Wolf River	l	r ob	r	g	F M	W	Am.	....	*
109	Yellow Bellefleur	l	ob	g y	v g	F M	W	Am.	—	**
110	Yellow Transparent	m	r ob	y	g	.....	E S	Rus.	**	*

APPLES—Crabs.

Number.	Names.	Description.							Value.	
		Size.	Form.	Color.	Quality.	Use.	Season.	Origin.	North.	South.
1	Hayden	....	.. ...	.....	.....	....	....	......	*	...
2	Hyslop	l	r	r	g	F M	A	Am.	*	*
3	Lady Elgin	l	r ob	y r	v g	F M	L A	Am.	**	....
4	Marengo	l	r fl	y r	g	F M	W	Am.	....	*
5	Montreal Beauty	l	r ob	y r	g	F M	A	Am.	....	*
6	Red Siberian	m	r	r	g	F M	A	F.	....	*
7	Transcendent	l	r ob	y r	g	F M	A	Am.	*	**
8	Van Wyck	....	......	....	.....	......	......	......	....	*
9	Yellow Siberian	m	r	y	g	F M	A	F.	....	*

BLACKBERRIES.

Abbreviations—*Size*,—l, large; m, medium; s, small. *Form*,—ob c, oblong conic; r c, roundish conical or oval; ob ov, oblong oval. *Color*,—b, black. *Quality*, —g, good; v g, very good; b, best. *Use*,— F M, family and market; M, market. *Season*,—M, medium; E, early; L, late. *Origin*,—Am, American; F, foreign.

Number.	Names.	Description.							Value.	
		Size.	Form.	Color.	Quality.	Use.	Season.	Origin.	North.	South.
1	Agawam	...	......	....	....	......	......	......	*	**
2	Ancient Briton	l	ob ov	b	v g	F M	M	Am.	....	†
3	Early Harvest	m	ov	b	g	F M	V E	Am.	...	—
4	Erie	l	ob ov	b	g	F M	M	Am.	....	†
5	Kittatinny	l	r c	b	b	F M	M	Am.	....	—
6	Lawton, *New Rochelle*	l	ov	b	g	M	L	Am.	....	—
7	Minnewaski	l	ov	b	g	M	M	Am.	....	†
8	Snyder	m	r ov	b	v g	F M	E	Am.	†	**
9	Stone (Hardy)	l	ob	b	g	F	.....	Am.	....	†
10	Taylor, *Taylor's Prolific*	l	......	b	g	F M	......	Am.	....	†
11	Tree, *Child's Ever-bearing Tree*	....	......	....	....	......	......	......	....	—
12	Wauchusett	m	ob ov	b	v g	F M	M	Am.	....	—
13	Wilson (Early)	l	ob ov	b	v g	M	E	Am.	....	*
14	Wilson Junior	l	ob ov	b	v g	M	E	Am.	....	†

DEWBERRIES.

Abbreviations.—Same as for blackberries.

Number.	Names.	Description.							Value.	
		Size.	Form.	Color.	Quality.	Use.	Season.	Origin.	North.	South.
1	Lucretia	l	ob ov	b	v g	F M	V E	Am.	....	†
2	Windom	....	......	....	....	......	......	......	†	†

CHERRIES.

ABBREVIATIONS.—*Size*,—l, large; m, medium; s, small. *Form*,—ob h, obtuse heart shape; r ob h, roundish obtuse heart shape; r h, roundish heart shape; r, roundish or round. *Color*,—l r, lively bright red; d r, dark red, almost black; a m, amber mottled with red; y r, yellow ground, shaded and marbled with red. *Use*,—F, family, for dessert: F M, family or market; K M, cooking or market; M, market. *Season*,—E, early; M, medium; L, late. *Origin*,—F, foreign; Am, American.

Number.	NAMES.	DESCRIPTION.						VALUE.	
		Size.	Form.	Color.	Use.	Season.	Origin.	North.	South.
	HEARTS AND BIGARREAUS.								
1	Bigarreau, *Graffion*, *Yellow Spanish*	l	ob h	y r	F M	M	F	....	†
2	Black Heart	l	r h	d r	F M	M	F	...	*
3	Black Tartarian	l	r h	d r	F M	M	F	....	*
4	Coe's Transparent	m	r	a m	F	M	Am	....	*
5	Downer's Late	m	r h	y r	F M	L	Am	....	*
6	Early Purple, *Early Purple Guigne*	m	r h	d r	F M	E	F	...	*
7	Elton	l	r h	y r	F M	M	F	....	*
8	Governor Wood	l	r h	y r	F M	M	Am	..	*
9	Napoleon	l	r ob h	y r	F M	M	F	....	*
10	Windsor	l	r h	d r	M	L	Am	....	†
	DUKES AND MORELLOS.								
41	Choisy	m	r	a m	F	M	F	....	*
12	Early Richmond.	s	r	l r	K M	E	F	....	*
13	Hortense	l	r	l r	F M	L	F	....	†
14	Late Duke	l	ob h	d r	K M	L	......	...	*
15	Louis Phillippe	l	r	d r	K M	L	F	....	*
16	Magnifique	l	r h	l r	K M	L	F	....	*
17	May Duke	l	r ob h	d r	K M	E	F	....	*
18	Montmorency, Large	l	r	d r	K M	M	F	....	†
19	Montmorency, Ordinaire	...	... .	....	.....	...	......	....	†
20	Morello, *English Morello*, *Large Morello*	l	r h	d r	K M	L	F	....	*

CURRANTS.

Abbreviations.—*Size*,—l, large; m, medium; s, small. *Form*,—with reference to form of bunch,—l, long; v l, very long; s, short; m, medium. *Color*,—r, red; b, black; w, white. *Quality*,—a, acid; m a, moderately acid; v a, very acid. *Use*,—K M, kitchen and market; F M, family and market; M, market. *Season*,—E, early; M, medium; L, late. *Origin*,—Am, American; F, foreign.

Number.	Names.	Description.							Value.	
		Size.	Form.	Color.	Quality.	Use.	Season.	Origin.	North.	South.
1	Black Naples	l	s	b	m a	K M	M	F	....	*
2	Cherry	l	s	r	v a	M	M	F	*	*
3	Fay, *Fay's Prolific*	l	l	r	m a	F M	M	Am	**	**
4	Lee, *Lee's Prolific*	l	l	b	m a	K M	M	F	....	*
5	Moore Ruby	m	....	......	....	......	.....	......	....	†
6	Prince Albert	l	l	r	m a	M	L	F	....	*
7	Red Dutch	m	m	r	m a	F M	E	F	*	*
8	Versaillaise, *La Versaillaise*	l	s	r	a	M	M	F	....	**
9	Victoria, *Raby Castle*	l	v l	r	a	F M	L	F	....	*
10	White Grape	m	l	w	m a	F M	E	F	**	**

GOOSEBERRIES.

Abbreviations.—*Size*,—l, large; m, medium; s, small. *Form*,—r, round; o, oval; r o, roundish oval. *Color*,—r, reddish when fully ripe: g, greenish yellow when fully ripe. *Quality*,—g, good; v g, very good; b, best. *Use*,—K, kitchen; M, market. *Season*,—E, early; M, medium; M L, medium-late. *Origin*,—Am, American; F, foreign.

Number.	Names.	Description.							Value.	
		Size.	Form.	Color.	Quality.	Use.	Season.	Origin.	North.	South.
1	Downing	m	r o	g	v g	K	M L	Am	*	**
2	Houghton	s	r o	r	g	K M	E	Am	**	**
3	Industry	l	r o	r	v g	K	M	F	....	†
4	Smith, *Smith's Improved*	l	o	g	v g	K M	M	Am	*	*
5	Whitesmith	l	o	g	v g	K M	M	F	....	†

GRAPES.

ABBREVIATIONS.—*Size*,—with reference to the berry,—l, large; m, medium; s, small. *Form*,—with reference to bunch and berry,—s r, short bunch, round berry; l r, large and round; m r o, medium bunch, roundish-oval berry; m r, medium bunch, round berry. *Color*,—b, black, or nearly so when fully ripe; r, reddish, or coppery-brownish red; g, greenish-white or yellowish. *Quality*,—g, good; v g, very good; b, best. *Use*,—T, table; M, market; W, wine. *Season*,—E, early; M, medium; L, late. *Origin*,—the species to which each variety belongs; Lab, *Vitis Labrusca; Æst, æstivals;* Rip, *Riparia*; Vulp, *Vulpina*. An X after one of the species denotes a cross with a variety of some other species. Hyb, hybrid between a foreign variety and one of the native species.

Number.	Names.	Description.							Value.	
		Size.	Form.	Color.	Quality.	Use.	Season.	Origin.	North.	South.
1	Agawam, *Rogers' No. 15*	l	s r o	r	g	T M	M	Hyb	....	*
2	Brighton	l	r	d r	v g	T	E	Hyb	....	†
3	Concord	l	l r	b	g	T M W	M	Lab	....	*
4	Delaware	s	s r	r	b	T M W	M	? X	....	*
5	Diana	m	s r o	r	v g	T M	L	Lab	....	—
6	Green Mountain	....	....	....	....	....	....	....	....	†
7	Hartford, *Hartford Prolific*	l	m r o	b	g	M	E	Lab	....	*
8	Iona	m	m r o	r	b	T M W	L	Lab	....	—
9	Moore's Early	l	r	b	g	T M	V E	Lab	....	**
10	Niagara	l	r	w	g	T M	M	Lab	....	†
11	Salem, *Rogers' No. 52*	l	r	b	g	M	M	Hyb	....	*
12	Wilder, *Rogers' No. 4*	l	l r	b	v g	T M	M	Hyb	....	*
13	Worden	l	r	b	g	T M	E	Lab	....	*
14	Wyoming	....	....	....	....	....	....	....	....	†

QUINCES.

ABBREVIATIONS.—*Size*,—l, large; m, medium; s, small; v, very. *Form*,—o, oblate; ob, obtuse: p, pyriform; r, roundish. *Color*,—g, greenish; y, yellowish. *Quality*,—h, half tender; t, tender. *Use*,—K, kitchen; M, market. *Season*,—E, early; L, late. *Origin*,—Am, American; F, foreign.

Number.	Names.	Description.							Value.	
		Size.	Form.	Color.	Quality.	Use.	Season.	Origin.	North.	South.
1	Alaskan	....	....	....	....	....	....	....	....	†
2	Angers	v l	r obp	y	t	M K	E L	F	....	*
3	Apple or Orange	l	r	y	h t	M K	E L	....	....	*

PEARS.

ABBREVIATIONS.—*Size*,—s, small; l, large; m, medium. *Form*,—p, pyriform; r o p, roundish obtuse pyriform: r a p, roundish acute pyriform; ob p, obtuse pyriform; ob o p, oblong obtuse pyriform; r, roundish; r ob, roundish obtuse. *Color*,—y g, yellow or yellowish green with a red or russet red cheek; y r, yellow and russet; y, when mostly yellow or yellowish. *Quality*,—g, good; v g, very good; b, best. *Use*,—F, valuable family dessert: K M, kitchen and market; F M, family and market. *Season*,—S, summer; L S, late summer; A, autumn; E A, early autumn; W, winter. *Origin*,—Eng, English; Am, American; F, Flemish; B, Belgium; H, Holland.

Number.	NAMES.	DESCRIPTION.							VALUE.	
		Size.	Form.	Color.	Quality.	Use.	Season.	Origin.	North.	South.
1	Admiral Farragut	l	r a p	y g	g	K M	A	Am	....	†
2	Angouléme, *Duchesse d' Angouleme*	l	ob o p	y	v g	F M	A	F	....	**
3	Anjou. *Beurre d' Anjou*	l	ob p	y g	v g	F M	L A	F	....	**
4	Bartlett	l	ob o p	y	v g	F M	L S	Eng	....	**
5	Bosc, *Beurre Bosc*	l	p	y r	b	F M	L A	B	....	*
6	Boussock, *Doyenne Boussock*	l	r o p	y r	v g	F M	E A	B	..	*
7	Buffum	m	r o p	y g	g	M	E A	Am	....	*
8	Clairgeau, *Beurre Clairgeau*	l	p	y r	g	M	L A	F	...	*
9	Clapp Favorite	l	ob o p	y g	v g	F M	S	Am	....	**
10	Diel, *Beurre Diel*	l	r ob p	y r	v g	F M	L A	B	....	*
11	Easter Beurre	l	r ob p	y r	v g	F	W	B	....	†
12	Eastern Belle	m	ob p	y r	v g	F	E A	Am	....	*
13	Flemish Beauty	l	r ob p	y g	v g	F M	E A	B	....	—
14	Fulton	s	r ob	y r	v g	F	A	Am	....	*
15	Giffard	m	p	y g	v g	F M	S	F	...	*
16	Goodale	l	ob p	y g	v g	F M	A	Am	....	†
17	Hardy, *Beurre Hardy*	l	ob p	y g	v g	F M	E A	......	....	*
18	Howell	l	r p	y g	v g	F M	E A	Am	....	*
19	Indian Queen	l	p	y g	g	K M	A	Am	....	†
20	Josephine of Malines	m	r ob p	y r	v g	F M	W	F	...	*
21	Lawrence	m	r o p	y r	v g	F M	W	Am	....	**
22	Louise Bonne of Jersey	l	ob p	y g	v g	F M	E A	F	....	**
23	Lucrative, *Belle Lucrative*	m	ob r	y g	b	F	E A	Fl	....	**
24	McLaughlin	l	ob p	y g	v g	F M	W	Am	....	*
25	Nickerson	l	ob p	y g	g	F M	A	Am	*	†
26	Onondaga, *Swan's Orange*	l	ob p	y g	v g	F M	L A	Am	....	*
27	Rostiezer	s	p	y g	b	F	S	.... .	....	*
28	Seckel	s	r	y g	b	F M	A	Am	....	*
29	Sheldon	m	r	y g	v g	F M	A	Am	....	**
30	Souvenir du Congres	l	p y r	y g	v g	F M	S	F	....	†
31	Summer Doyenne, *Doyenne d' Ete*	s	r o p	y g	v g	F	S	B	....	*
32	Superfin, *Beurre Superfin*	m	r p	y r	v g	F	A	F	....	*
33	Tyson	m	r a p	y g	b	F	S	Am	....	*
34	Vicar, *Vicar of Winkfield, Le Cure*	l	p	y	g	K M	W	F	....	*
35	Winter Nelis	m	ob p	y r	b	F M	W	B	..	*

PLUMS.

ABBREVIATIONS.—*Size*,—l, large; m, medium; s, small. *Form*,—o, oval; ob, obovate; r, roundish. *Color*,—g, greenish; p, purplish; r, reddish; y, yellow. *Quality*,—g, good; v g, very good; b, best. *Use*,—F, family; M, market. *Season*,—E, early; L, late; M, medium. *Origin*,—Am, American; F, foreign.

Number.	Names.	Description.							Value.	
		Size.	Form.	Color.	Quality	Use.	Season.	Origin.	North.	South.
1	Abundance	m	r o	p	g	F M	M	Jap	....	†
2	Bavay, *Bavay's Green Gage*	l	r	g y	b	F	L	F	...	**
3	Bleeker Gage	m	r o	y	v g	F M	M	Am	...	*
4	Burbank	m	r	p	g	F M	M	Jap	....	†
5	Bradshaw	l	o ob	r p	g	M	M	Am	....	*
6	Coe Golden Drop	l	o	y r	v g	F M	L	F	....	*
7	Columbia	l	r	p	g	M	M	Am	....	*
8	Damson	s	o	p	g	M	L	Am	*	*
9	De Soto	m	r o	y r	v g	F M	M	Am	†	†
10	Duane Purple	l	o	r p	g	F M	E	Am	....	*
11	Forest Garden	m	r	r	v g	F M	E	Am	†	†
12	Green Gage	s	r	g y	b	F	M	F	*	*
13	Huling, *Huling Superb*	l	r o	g y	g	F M	M	Am	....	*
14	Imperial Gage	l	o	g y	b	F M	M	Am	.	**
15	Italian Prune, *Fellemburg*	m	o	p	g	F M	M	F	...	*
16	Jefferson	l	o	y r	b	F M	M	Am	...	*
17	Lombard	m	r o	r p	g	M	M	Am	—	*
18	McLaughlin	l	r	y r	b	F M	M	Am	....	**
19	Moore Arctic	m	r o	p	g	F M	M	Am	**	*
20	Penobscot	....	....	....	.....	.....	....	Am	....	*
21	Pond, *Fonthill*	l	o	y r	g	M	M	F	....	*
22	Purple Gage	m	r	p	v g	F M	M	.....	....	*
23	Quackenboss	l	r	p	g	M	M	Am	....	*
24	Rollingstone	....	....	....	.....	.....	....	Am	†	†
25	Shropshire Damson	s	o	p	g	F M	L	Eng	....	*
26	Smith Orleans	l	o	r p	v g	F M	M	Am	*	*
27	Washington	l	r o	g y	v g	F M	M	Am	....	*
28	Wolf	m	o	y r	g	F M	M	Am	†	†
29	Yellow Egg, *White Magnum Bonum*	l	o	y	g	F M	M	......	....	*

1 and 4 Japanese varieties which can succeed only in the southern parts of the State. 9, 11, 24 and 28, improved varieties of *Prunus Americana*, the native "horse plum" or "pomegranate." 19, the most popular variety for Aroostook county.

RASPBERRIES.

ABBREVIATIONS.—*Size*,—l, large; m, medium; s, small; v, very. *Form*,—c, conical; o, obtuse; r, roundish. *Color*,—b, black; p, purplish; r, reddish; y, yellow. *Quality*,—b, best; g, good; v, very. *Use*,—M, market; F, family. *Season*,—E, early; L, late: M, medium. *Origin*,—Am, American; F, foreign.

Number.	NAMES.	DESCRIPTION.							VALUE.	
		Size.	Form.	Color.	Quality.	Use.	Season.	Origin.	North.	South.
	SUB-SECTION I.—RUBUS IDÆUS.									
1	Clarke	m	r	r	g	F M	E	Am	....	*
2	Herstine	l	ob c	r	v g	F M	M	Am	....	†
3	Knevett	l	ob c	r	b	F	M	F	...	—
4	Orange, *Brinckle's*	l	c	y	b	F	M	Am	....	—
	SUB-SECTION II.—R. NEGLECTUS.									
1	Philadelphia	m	r	p	g	M	M	Am	....	—
2	Shaffer	v l	r	p	g	F M	M	Am	....	*
	SUB-SECTION III.—R. OCCIDENTALIS.									
1	Gregg	v l	r	b	g	F M	M	Am	....	**
2	Hilborn	...	......	...	....	......	.....	......	....	†
3	MacCormick, *Mammoth Cluster*	m	ob c	b	v g	F M	L	Am	....	*
4	Nemeha	...	......	...	....	......	.....	......	....	†
5	Souhegan	m	r	b	g	F	E	Am	...	*
6	Tyler	m	r	b	v g	F M	E	Am	....	*
	SUB-SECTION IV.—R. STRIGOSUS.									
1	Cuthbert, *Queen of the Market*	l	r o	r	g	F M	M	Am	....	**
2	Golden Queen	l	r o	y	v g	F M	M	Am	....	**
3	Hansell	m	r o	r	v g	F M	V E	Am	....	†
4	Marlboro	l	r c	r	g	F M	M	Am	....	*
5	Turner	m	r	r	g	F M	E	Am	....	*

STRAWBERRIES.

Abbreviations.—*Size*, l, large; s, small; m, medium. *Sex*,— B, bisexual; P, pistillate; P B, nearly pistillate. *Color*,—d c, deep crimson; d s, deep scarlet; b s, bright scarlet; w t, whitish tinted with red; l c, light crimson. *Form*,—r c, roundish conical; o c, obtuse conical or coxcomb form; c, conical; r, roundish; r o c, roundish obtuse conical. *Flesh*,—s, soft; f, firm; m, medium. *Season*,—E, early; M, medium; L, late; E L, early to late. *Origin*,—Am, American; F, foreign.

Number.	Names.	Description.							Value.	
		Size.	Sex.	Color.	Form.	Flesh.	Season.	Origin.	North.	South.
1	Beeder Wood	....	....	......	.....	....	......	....	....	†
2	Beverly	....	....	......	.....	....	......	....	....	†
3	Boynton	....	...	......	. ...	....	.. ...	....	....	†
4	Bubach No. 5	....	P	......	......	....	......	Am	*	*
5	Burt	....	....	......	.....	...	......	......	....	†
6	Charles Downing	l	B	d s	c	f	M	Am	*	*
7	Col. Cheney	l	P	b s	o c	f	M	Am	...	*
8	Crawford	l	B	b c	o c	m	M	Ohio	...	†
9	Crescent	l	P	b s	r c	m	M	Am	**	**
10	Cumberland, *Cumberland Triumph*	v l	B	b s	r c	s	M	Am	....	*
11	Gandy	....	B	b r	c	f	......	Am	....	†
12	Haverland	l	P	r s c	o c	m	M	Am	....	**
13	Jessie	v l	B	b s	r c	m	M	Am	....	*
14	Manchester	l	P	s	o c	f	M	Am	....	*
15	May King	....	....	......	.....	.. .	.....	......	....	*
16	Michel's Early	....	..	......	......	...	......	.....	....	†
17	Miner, *Miner's Great Prolific*	v l	B	c	r c	m	M	Am	....	*
18	Monmouth	....	....	......	......	....	......	......	...	†
19	Mrs. Cleveland	....	....	......	......	....	......	......	....	†
20	Parker Earle	l	B	b r	l c	f	M	Tex	....	†
21	Pearl	m	B	d r	o c	f	M	Am	....	†
22	Sharpless, *Ontario*	v l	B	b r	o c	f	M	Am	....	*
23	Triomphe de Gand	l	B	l c	o c	f	M	F	....	*
24	Warfield	m	P	d r	c	f	M	Ill	....	†
25	Wilson, *Wilson's Albany*	l	H	d c	r c	f	E L	Am	....	*

SELECT VARIETIES.

1. *For the Northern Counties.*

APPLES—*Summer and Autumn.* Yellow Transparent, Oldenburg, Alexander, Lady Elgin crab. *Winter.* Dudley's Winter (North Star,) Fameuse, Hayford Sweet, Wealthy.

PEARS—Fulton, Eastern Belle, Nickerson, Tyson, Vermont Beauty.

PLUMS—Moore Arctic, Green Gage, Smith's Orleans, and possibly De Soto. Forest Garden and Wolf.

SMALL FRUITS—Agawam blackberry; Cuthbert, Turner and Tyler raspberries; Fay and White Grape currants; Downing and Houghton gooseberries.

2. *For the Southern Counties.*

APPLES—*Summer and Autumn.* Yellow Transparent, Oldenburg, William's Favorite, Dyer (Pomme Royal,) Gravenstein, Fall Harvey, High Top Sweet, Munson Sweet, Ramsdell Sweet.

Winter—Baldwin, Fameuse, Granite Beauty, Hubbardston, Jewett Red (Nodhead), Milding, Mother, Northern Spy, Rhode Island Greening, Rolfe, Roxbury Russet, Talman Sweet, Wealthy, Yellow Bellflower.

PEARS—Clapp Favorite, Bartlett, Louise Bonne of Jersey, Sheldon, Angouleme, Anjou, Lawrence.

PLUMS—Bavay, Imperial Gage, Lombard, McLaughlin.

CHERRIES—Black Heart, Downer's Late, Governor Wood, Early Richmond, English Morello.

RASPBERRIES—Cuthbert, Golden Queen, Shaffer, Gregg.

BLACKBERRIES—Agawam, Snyder.

CURRANTS—Fay, Prince Albert, Versaillaise, Victoria, White Grape.

GOOSEBERRIES—Downing, Smith, Whitesmith.

GRAPES—Green Mountain, Hartford, Moore's Early, Worden.

STRAWBERRIES—Bubach No. 5, Crescent, Haverland, Sharpless, Wilson.

* 3. *Select Apples for Home Use.*

Summer and Autumn: Yellow Transparent, Oldenburg, Dyer, Gravenstein, High Top Sweet, Munson Sweet.

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*The varieties here suggested are known by the writer to be of value for the purposes named in certain parts of the State. There may be some sections where local conditions would render other sorts more valuable.

Winter—Fameuse, Hubbardston, Mother, Northern Spy, Rhode Island Greening, Rolfe, Roxbury Russet, Winter Sweet Paradise, Talman Sweet.

*4. *Select Apples for Market.*

Summer and Autumn: Oldenburg, Gravenstein, High Top Sweet.

Winter—Baldwin, Ben Davis, Hubbardston, Rhode Island Greening, Roxbury Russet, Talman Sweet, Yellow Bellflower.

5. *Apples Tried and Found Wanting in the Northern Counties.*

Baldwin, Ben Davis, Black Oxford, Blue Pearmain, Fall Queen, (Haas), Gravenstein, Grimes Golden, High Top Sweet, Mann, Northern Spy, Peabody Greening. Porter, Rhode Island Greening, Rolfe, Sops-of-Wine, Talman Sweet, Tompkins King, Williams (Favorite), Yellow Bellflower.

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*See note on page 143.

Report of Botanist and Entomologist.

Prof. F. L. Harvey.

Professor W. H. Jordan:

Dear Sir—I have the honor to submit herewith my sixth annual report as Botanist and Entomologist for the Experiment Station. The demand for information about injurious fungi, weeds, forage plants and injurious insects is increasing. More letters of inquiry were received the past season than ever before. Many of these letters were about insects and fungi already considered and figured in previous reports and from parties who must have had access to the Station Reports. It is apparently less trouble to send specimens to the Station for examination and positive determination than to look them up in the reports. Extensive and carefully detailed correspondence must form an important feature of Station work. Such letters are usually answered by referring to the published accounts in the Station Reports. Specimens when new to the State are reported upon in detail, and if of sufficient interest are considered and figured in the annual report. Below will be found tabulated and considered the most important plants and insects that have been studied the past season The season has not been marked by the extreme ravages of any insect, or the widespread prevalence of any species of fungus, though some of those that gave trouble last season have increased and a few have been added to the list of our State pests.

Pear-Leaf Blight seems to be spreading in the western part of the State in the vicinity of Portland. Any whose pears crack open in ripening will do well to read the article on this disease in Experiment Station Report, 1892, page 109. The Bean Anthracnose, a disease that causes brownish spots upon snap beans, (especially the white-podded varieties), was quite prevalent the past season. Tomato Anthracnose, a fungus attacking ripening and ripe tomatoes was abundant in the Station garden and elsewhere in the State. The Beet Scab, a disease causing warty excrescences upon beet roots, and said to be produced by the same fungus as Potato Scab was abundant in the Station garden and other places in the State. The Clover Rust was unusually bad (especially on second-growth clover,) about Orono. A new tomato disease causing depressed dark patches upon ripened tomatoes did considerable damage to the Station tomato crop. The STRAWBERRY SEPTORIA was very abundant upon Station strawberries. The ORANGE HAWK-WEED still spreads. As it seeds before harvest, spreads by runners at the roots and is perennial it will yield to nothing but the spade and hoe, and the earlier attended to the less trouble. The ARISTATE PLANTAIN, a near relative of the ENGLISH PLANTAIN has made its appearance in the State. In response to an enquiry regarding wild rice we have learned that it is plentiful in the State.

THE FALL CANKER WORM is gradually spreading. Besides apparently holding its own in known localities several new localities have been reported the past season. This species is sometimes accompanied by the LIME-TREE WINTER-MOTH an insect similar in its habits but checked by spraying like the CANKER-WORM

THE ANGOUMOIS GRAIN MOTH was found in great numbers in boxes of *Shaker Pop Corn* offered for sale in Orono. This is one of the worst grain insects. The grain exhibits at the World's Fair were badly infested with it. It is capable of doing much damage to stored grain and its spread in the State would be a misfortune.

THE STALK BORER, (*Gortyna nitela*, GUEL.,) and THE BLACK CANTHARIS, (*Cantharis atrata*,) were both reported as doing damage to potatoes; the former boring into the stalks, the latter in great numbers feeding upon the foliage.

THE RED-HUMPED APPLE TREE CATERPILLAR seems to be increasing in the State. It was reported from a new locality this season and we found it also in the Station orchard, probably introduced on nursery stock.

THE APPLE-LEAF BUCULATRIX, (*B. pomifoliella*, Clemens.) A small moth, the larva of which skeletonizes the leaves of apple trees was reported as doing considerable damage. This insect has not been noticed before.

Specimens of pears received from F. Frank Jones, Portland, bore the characteristic cuts of the PLUM CURCULIO. Some of the fruits had five incisions and were badly dwarfed and distorted.

THE STRIPED SQUASH BEETLE, a very common garden pest seems to have been unusually abundant the past season. Thick planting and then thinning, as the plants get older; protecting the seedlings by boxes or half hoops and netting, or even hand picking the beetles will usually insure a good stand of cucurbitaceous plants.

Mr. C. A. Wood of Searsport sent us a species of ROVE BEETLE, *Ancyrophorus planus*, and THE FOUR-SPOTTED PITHYOPHAGUS, *P. 4-guttatus*. Both were accused of destroying the kernels of sweet corn at the top of the ear. Ears of damaged corn accompanied the accused. We were able to acquit the above beetles as the corn showed the unmistakable work of the CORN WORM which was considered in our last report on P. 119. The true culprits, full fed, had probably crawled away to transform. The above insects were in the corn to feed upon the sugary and starchy matter that flowed from the broken kernels.

THE WHITE GRUB or larva of the MAY BEETLE, *Lachnosterna fusca*, has been doing much damage to grass lands in the vicinity of Bridgton. As there is no certain remedy known for this insect it would be advisable to do some field work upon it and try the most hopeful remedies suggested by entomologists and prove their value or worthlessness.

THE PEAR BLIGHT BEETLE working in the limbs of apple trees and boring the wood full of small channels is a new injurious insect to the State.

We reeceivd specimens from two widely separated localities so it must be widespread. Its presence can be detected by small shot-like holes in the bark. It attacks healthy trees and there is no remedy but to cut the branches infested and burn them.

The BEAN WEEVIL spoken of in our last report is considered and illustrated in this. The HORN FLY was quite abundant in some localities. It is migrating eastward and was quite abundant at Hudson and other localities in the Penobscot valley this season.

The CARROT FLY, *Psila rosæ*, was received from Mr. C. H. Morrell, Pittsfield. It was found infesting stored carrots. This is a European insect never before detected in the United States. The carrots were literally alive with maggots.

Beets in this region were badly infested by a species of *Anthomyia* or BEET FLY, the larvæ of which eat the pulp from the leaves, leaving the epidermis. The eaten spots are clear whitish and in them the maggots can often be seen between the epidermi.

THE CURRANT PLANT LOUSE, *Aphis ribes*, L. has been doing damage to gooseberries in Aroostook and Piscataquis counties the past season, destroying the foliage and causing a second growth of small leaves.

THE APPLE MAGGOT, *Trypeta Pomonella*, Walsh, still is doing much damage in Maine as well as in adjoining states, if we can judge from the demand for our article on this insect, published in the Station Report for 1889. We received a long newspaper article from a New Hampshire correspondent, which he had written to give the fruit growers of his state the life history of this pest. The article was accompanied by specimens in the "*long-winged*" stage of their development, graphically described by the writer. The specimens were a species of ICHNEUMON which does not even belong to the same order as Trypeta, which is a *two winged* fly. The article was full of other errors. We notice this merely to warn farmers and fruit growers against articles upon technical subjects by non-professionals. To trace the life history of an insect requires great care, and a knowledge of insect forms that can not possibly be obtained except by long experience.

In the above mentioned article at least *three insects* belonging to *different orders* were regarded as *stages* in the life history of *Trypeta* and *none of them pertained to that insect*. The best way is to send injurious insects to the professional entomologist. *Absolute* identification of a p st is the first thing necessary in coping with it.

THE CHINCH BUG still continues to do damage to meadow lands in the vicinity of Fryeburg. It will be well to do some field work in that region another season to learn the extent of the infested district and gain any information that will enable us to suggest remedial measures.

Tetranychus 2-maculatus, Harvey, was reported from Piscataquis county the past season. While we were in Chicago, during July, specimens of this mite were submitted to us for examination. They came from a greenhouse near Chicago, showing this pest is widely distributed.

DIRECTIONS FOR SENDING SPECIMENS.

Regardless of the careful directions given in previous reports for sending insects, several specimens were received the past season, in envelopes or fragile paper boxes and when they arrived were crushed almost beyond recognition. Other packages came without the name and address of the sender upon them. Insects should *always* be sent in wooden or tin boxes and some of the food plant or injured material enclosed. Notes upon the habits of the insect should accompany the specimens, and the sender's name and address should be upon the package even if a separate letter is written. We sometimes receive several packages the same day and if not plainly marked we are unable to tell from whom they come.

Directions for sending specimens will be found in the Annual Report of the Experiment Station, 1888, p 194, or in Maine Agricultural Report, 1888, p. 158. Correspondence regarding injurious insects and fungi is invited. Insects and plants will be named, and when injurious, remedies suggested. It is to the interest of farmers to detect injurious insects and fungi before they become established, so that remedial measures can be adopted before the pests are beyond control. As the Entomologist's duties prevent him from going much about the State, it is largely through correspondence that the Station learns of insects doing injury in the State.

REMARKS.

The cuts and plates to illustrate this Report were obtained from the following sources: From the Department of Agriculture, Washington, D. C.; the plate of Plantago Patigonica, cuts of the Angoumois Grain Moth, and cuts of the May Beetle; from J. B. Lippincott & Co.; cuts of the Lime-tree Winter-moth, the Apple-leaf Bucculatrix, the Disippus Butterfly and the Pear-blight Beetle; from Prof. A. E. Popenoe, cuts of the Bean and Pea Weevils; cuts of the bean Anthracnose and Carrot Fly are from original drawings made by the writer.

PLANTS REPORTED AND EXAMINED—1893.

No.	Common Name.	Technical Name.	From Whom Received.	Remarks.
1	Hair Mold	*Phycomyces mitens*	Chas. P. Kitridge, Milo	On excrement. See Experiment Station Report, 1892, p. 111.
2	Pear-leaf Blight	*Entomosporium maculatum*, Lev.	T. Frank Jones, Portland	Attacking the leaves and fruit of pear trees. See Experiment Station report, 1892, p. 109.
3	Bean Anthracnose	*Colletotrichium Lyndemuthianum*, (S and M) (B and Cav.)	Eugene T. Perkins, Kennebunkport Prof. W. H. Jordan, Orono	Causing brown spots on the pods of beans.
4	Anthracnose of the Tomato	*Colletotrichum phomoides*, Sacc.	F. L. Harvey, Orono	Causing ripe rot on tomatoes.
5	Beet and Potato Scab	*Oospora scabies*, Thaxter	F. L. Harvey, Orono	Causing warty excrescences on beet roots and scab on potatoes.
6	Orange Hawkweed	*Hieracium aurantiacum*, L.	E. W. Dutton, New Sharon	Coming uninvited into fields.
7	Aristate Plantain	*Plantago Patigonica* var. *aristata*, Gray.	Mrs. A. M. Pikes, East Madison	In oat field.

INSECTS REPORTED AND EXAMINED—1893.

No.	Common Name.	Technical Name.	From Whom Received.	Remarks.
1	Fall Canker Worm	*Anisopteryx pometaria*, Harris	B. Walker McKeen, Augusta, Chas. S. Pope, Manchester, W. F. Hilt, Warren, Samuel Milliken, W. Scarboro	Eggs on apple trees; wingless females on side of house; larvæ feeding on foliage of apple trees.
2	The Angoumois Grain Moth	*Gelechia cerealella*, L	F. L. Harvey	Found in *Sure Pop* Shaker Corn in a store in Orono.
3	The Stalk Borer	*Gortyna nitela*, Guen	H. B. Whipple, Bingham	Boring potato stalks.
4	The Io Emperor Moth	*Hyperchiria Io* (Linn)	F. H. Parlin, East Winthrop	
5	The Lime-tree Winter Moth	*Hybernia tillaria*, Harris	F. W. Hilt, Warren	With the females of the Fall canker worm crawling on the side of a house.
6	The Red-humped Apple-tree Caterpillar	*Œdemasia concina*, (Sm. and Abb.)	F. L. Harvey, College orchard. Miss May Thurlow Farrow, Centre Belmont	Feeding on foliage of apple trees. See Station Report, 1890, page 135.

7	THE GREAT AMERICAN TIGER-MOTH	*Arctia Americana*, Pack.	D. H. Knowlton, Farmington	This is a rare moth in Maine. Of no special economic importance.
8	THE APPLE-LEAF BUCCULATRIX	*Bucculatrix Pomifoliella*, Clemens.	D. P. Boynton, Monmouth	Injuring the foliage of apple trees.
9	THE DISIPPUS BUTTERFLY	*Limenitis disippus*, Godt.	Fred B. Pike, Cornish	Feeding on willows.
10	THE PLUM CURCULIO	*Conotrachelus nenuphar*, Herbst	F. Frank Jones, Portland	Several varieties of pears showing the cuts of the plum curculio.
11	THE STRIPED SQUASH BEETLE	*Diabrotica vittata*, Fabr.	J. W. Black, Searsport	Obtained from Mr. C. A. Woods.
12	ROVE BEETLE	*Ancyrophorus planus*, Lec.	J. W. Black, Searsport, from C. A. Woods, Searsport	Feeding on the starchy matter of ears of corn that had been injured by the Corn Worm. See Experiment Station Report, 1893, p. 192.
13	FOUR SPOTTED PITHYOPHAGUS.	*Pithyophagus 4-guttatus*	J. W. Black, Searsport, from C. A. Woods, Searsport	With the above feeding upon the exuded milk of corn attacked by the Corn Worm.
14	THE WHITE GRUB OR MAY BEETLE	*Lachnostema fusca*, Trohl	J. L. Wale, Bridgton	Destroying meadows.
15	BLACK CANTHARIS.	*Cantharis atrata*	H. B. Gray, Blue Hill	Feeding on potato vines.
16	BEAN WEEVIL	*Bruchus obtectus*, Say	Samuel Libby, Orono	Working in stored beans.
17	THE PEAR BLIGHT BEETLE	*Xyleborus pyri*, Peck, = *Xyleborus dispar*, Fabr.	J. M. Allen, North Sedgwick, Dr. Twitchell, Augusta	Boring in the limbs of apple trees.
18	THE HORN FLY	*Haematobia serrata*	A. T. Wing, North Fayette	See Experiment Station Report, 1892, p. 131.
19	THE CARROT FLY	*Psila rosae*, Fab	C. H. Morrell, Pittsfield	Larvæ badly infesting stored carrots. New to United States.
20	THE BEET OR MANGOLD FLY	*Anthomyia betae*, Curtis	O. T. Goodrich, Orono, F. L. Harvey, Orono	Feeding on the pulp of beet leaves reducing them to a dry papery skin.
21	OYSTER-SHELL BARK-LOUSE	*Mytilaspis pomorum*, Bouchè	Miss Georgine V. Wilbur, Phillips	On apple trees. See Experiment Station Report, 1888, p. 157.
22	THE CURRANT PLANT LOUSE	*Aphis ribis*, L	Chas. P. Kittredge, Milo Delano Moore	Attacking gooseberry leaves. Causing clusters of second growth leaves.
23	THE COTTONY MAPLE SCALE	*Pulvinaria innumerabilis*, Rathvon	C. M. Randlette, Richmond	On maple leaves.

BOTANY.

BEAN ANTHRACNOSE.

Colletotrichium Lindemuthianum, (Sacc & Magn) Briosa & Cavara.

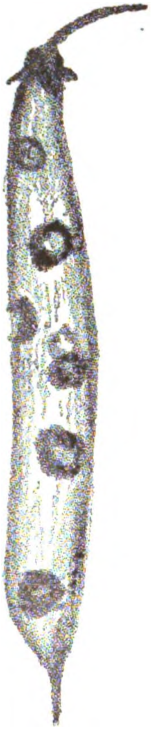


FIG. 1—Bean Anthracnose, pod showing pits formed by the disease (original)

The above disease of the bean has been quite common in gardens and fields about Orono for the past seven years and we presume it is prevalent throughout the State. It was unusually bad the past season, and specimens were received from distant localities and inquiries made regarding it. It is probably the worst disease of the bean and as its ravages can be largely controlled by proper precautions and treatment, the following consideration of the fungus may prove helpful in combating it. The BEAN ANTHRACNOSE is a parasitic fungus attacking the stem, leaves and pods of both bush and pole beans, producing, especially on the pods, sunken brownish pits or spots surrounded by a reddish brown border. See Fig 1. In the central part of these pits are little pinkish dots which are the spore masses that have exuded from below. The spores are held together by a gummy substance that is soluble in water and they may be liberated by dew or rain or excessive moisture and then are free to be blown by the wind to healthy plants, where they germinate and spread the disease. The disease is worst upon the white podded bush and pole beans but will also attack the more hardy varieties. The past season it was quite bad upon YELLOW EYES in the field. We lost the greater part of our garden crop of German Wax the past season, the pods becoming so covered with pits before they were large enough to pick as to be worthless. The effects of this disease are to lessen the stand when it destroys the seedlings; to dwarf the plants and make the pods swollen and when it spots the pods to render them unfit for snap beans, also to finally injure the bean in the pods. This disease may originate from infected seed or, we think, it may live over winter in the beans and pods that are left in the garden. When infected seed is planted the disease shows itself early in the seedlings. Much of the seed of German Wax beans offered for sale is infected. The past season fully half of the seedlings in our garden were affected when they appeared above ground and not more than two-thirds of the seed came up. The remaining plants were dwarfed and early showed the presence of the disease. We procured new seed and made a second planting.

We have *purchased* our seed for the past seven years from that offered for sale by prominent dealers and have never had a crop free from the disease. It is common among gardeners to leave the bushes with the diseased pods upon them to rot on the ground, and to plant a second crop in the same place. We practice rotation of crops even in the garden with good results. It is a good practice to clear a garden in the fall of all refuse and carefully burn it. By doing this, fungi that live in the decaying organic matter are destroyed, along with hybernating insect pests. Beans should be planted on a light dry soil, in hills, or if in rows far enough apart to give good circulation of air. Moisture favors the growth of *Anthracnose* and other bean diseases. Care should be taken not to hoe beans after a rain or when the dew is on for the dirt that sticks to the leaves is liable to contain spores that will germinate and rapidly spread the disease. Professor Jordan showed us some badly spotted pods that were apparently free from the disease when purchased in the Orono market a day or two before.

If possible secure seed from your own, or a neighbor's field that was free from disease. It is hazardous to plant seed from an infested field. If obliged to take seed from a field that has been diseased pains should be taken to select pods from plants that have escaped the disease. All beans that show sunken pits, discolored patches, or are even wrinkled or blistered should be rejected. Diseased seedlings should be pulled as early as possible and removed from the field or burned, as the fungus will ripen its spores in the decaying plant. Some practice spraying beans with *Bordeaux mixture* early in the season, and claim that the fungus is controlled by it. The following precautions should materially lessen the disease:

I. Select good seed, rejecting all beans that seem at all unsound.

II. Should the disease appear in the young beans carefully destroy all affected seedlings.

III. If convenient spray early with Bordeaux mixture and repeat the application if needed before the pods form.

IV. Do not plant on ground that has borne an infected crop the past season.

V. Plant on a dry soil in hills or in rows far enough apart to admit air freely. Hoe when the ground and foliage are dry.

TOMATO ANTHRACNOSE.

Colletotrichum phomoides, Sacc.

This fungus appeared last fall in the station garden upon ripening and fully ripe tomatoes and did considerable damage. Tomatoes that were apparently sound developed the disease rapidly after they were gathered. This fungus is capable of doing much damage to the ripening crop and the ripe fruit can not be kept any time or marketed. We understand from Professor Munson that the disease has done damage elsewhere in the State. Professor Chester described this fungus as *C. lycopersici*, n. s p. in the Fourth Report of the Delaware Station, but in the Fifth Report of the same station, p. 80, 1892, he refers the fungus back to *C. phomoides*. Sacc. Our species is the same as the one considered by Professor Chester, as we sent specimens to him for comparison. He has kindly loaned us the fine cuts which are used to illustrate this article.

Professor Chester is of the opinion that the characters used by botanists to separate the genera *Colletotrichum and Glœsporium*, viz.: the presence or absence of setæ in the fruiting tufts, is evanescent. If this should be established the genus *Colletotrichum* would be merged into *Glœsporium*. The investigations of Miss Southworth, Professor Halsted and Professor Chester indicate that several forms of *Glœsporium* separated as species on account of living on different host plants will have to be merged, or that there is a species of *Glœsporium one and the same*, capable of a wide range of parasitism and of producing *Anthracnose* on a variety of hosts. It looks as though careful laboratory methods would make havoc with the present nomenclature of fungi, by merging stages of the life history of forms and uniting species that have been separated on the principle, that each host harbors its peculiar parasites. The above is only of importance to mycologists. The characters and treatment are of more interest to the grower of tomatoes.

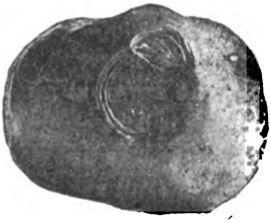
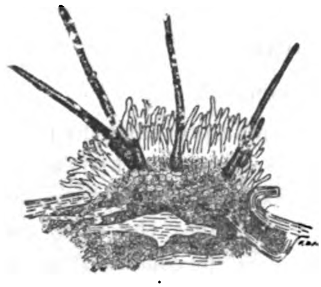


FIG. 2. Tomato. Affected by Anthracnose. Colletotrichum phomoides, Sacc.

CHARACTERS.



* Fig. 3. A fruiting tuft of Colletotrichum phomoides, Sacc. Tomato-Anthracnose.

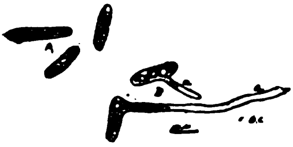


Fig. 4. A. Mature spore. B. Germinating spore of Colletotrichum phomoides, Sacc.

This disease makes its appearance upon ripening or fully ripe tomatoes upon the vines or develops rapidly upon gathered fruit. It appears on the tomatoes as rounded, sunken, discolored, wrinkled spots with a black centre. See Fig. 2. Contiguous spots become confluent forming diseased areas. An examination of these dark parts in the diseased areas, discloses numerous microscopic, oblong bodies, the *spores* of the fungus. See Fig. 4. These spores reproduce the disease. Prof. Chester found that these spores inserted under the skin of healthy tomatoes would rapidly cause the disease. Not being able to develop the disease by putting the spores on the unbroken skin of the green and ripe tomatoes would indicate that the disease is an internal parasite and can not be reached by spraying with Potassium Sulphide as is recommended by Mr. Bragg of the Oregon Station in a recent bulletin.

This disease opens the way for the attack of other species of fungi that hasten the decay.

Fig. 3. shows a cross section of one of the diseased spots highly magnified.

REMEDIES.

1. Spray the vines and young fruit with Potassium Sulphide (Liver of Sulphur)—formula.—Dissolve seven ounces of Potassium Sulphide in twenty-two gallons of water and apply with a spraying apparatus. As stated above this may not be useful for this disease but is regarded a remedy for external tomato fungi.
2. Gather all diseased vines and tomatoes and burn them.
3. Change the location of the tomato patch if the crop has been affected.
4. Do not take seed for planting from diseased tomatoes.

POTATO AND BEET SCAB.

Oospora scabies, Thaxter.

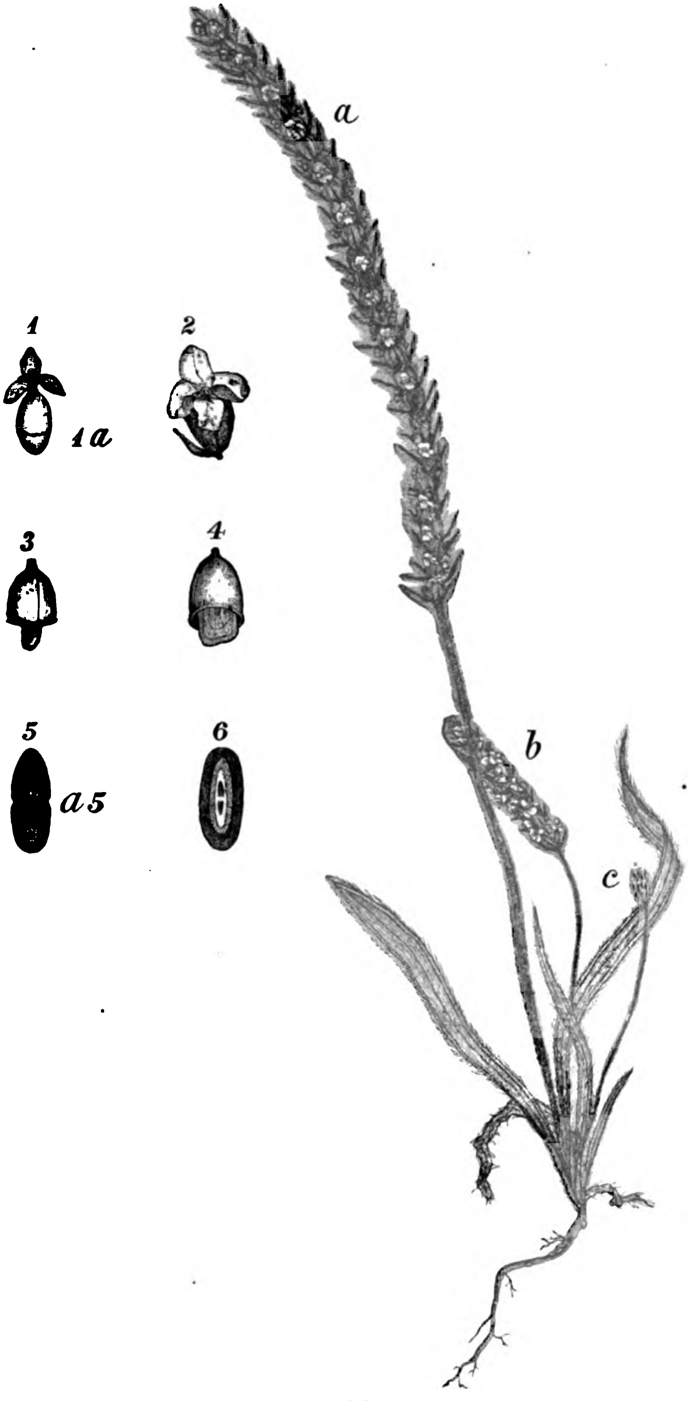
The scab of potatoes and beets has been quite prevalent the past season. The ordinary disease of potatoes and beets known as "scab" has been demonstrated by Dr. Thaxter to be due to the same fungus, the species named above. Now that the cause is known experiments for checking the disease can be conducted upon a rational basis. Professor Bolley exhibited at the World's Fair, Chicago, in the exhibit of the office of experiment stations, two jars of potatoes grown under similar conditions from scabby seed. One lot was treated with a dilute solution of corrosive sublimate and the other lot was untreated. The former lot was comparatively free from scab and well grown. The latter badly scabbed and dwarfed.

This would indicate that scabby seed may be the cause of the disease and that clean seed should be planted. It would also follow that scabby seed *treated* will produce much better potatoes than scabby seed *untreated.*

We feel positive that the disease cannot be controlled merely by planting clean seed. The last season we planted clean seed upon soil that had not grown potatoes for two years and raised a badly scabbed crop. It seems certain that this disease may live in the organic matter of the soil even more than one year or else has other hosts which have not been discovered upon which it maintains itself.

Will treating clean seed with corrosive sublimate give a better crop than clean seed untreated? If not we see no great use for it, for clean seed is usually obtainable.

Experiments to show the vitality of this fungus in soil not growing potatoes are desirable in order to learn whether a system of rotation may not clean the soil of the disease. Experiments should be conducted with clean seed upon grass lands in order to learn whether they are free from the fungus and settle the question whether newly turned grass land is better for potatoes. The study of fertilizers in relation to the introduction of this disease is important. Considerable more study upon the conditions of growth of this fungus is necessary.



WESTERN PLANTAIN.

Plantago Patigonica, var. aristata, Gray.

Figs. a, b and c show spikes in different stages of growth. Fig. 1. Back view of flower with calyx removed Fig. 2, front views with calyx and basal bract. Figs. **3 and 4, portions of capsules. Figs.** 5 and 6, dorsal and ventral views of the seed.

WESTERN PLANTAIN.

Plantago Patigonica, *var. aristata*, Gray.

Specimens of the above plant were received the past season from Mrs A. M Pikes, East Madison, Somerset county, and found growing in an oat field. This plant belongs to the *Order Plantaginaeæ* and is a near relative of the ENGLISH PLANTAIN considered in Experiment Station Report, 1890, p. 119. It was probably introduced with the seed. A few specimens were found growing on the college campus a year or two ago, introduced with grass seed, but they were not allowed to drop their seed. This plant is widely distributed in South and North America and in the West is a bad weed It presents a number of varieties besides the one named above. As it has become established on Martha's Vineyard and about Boston it would no doubt find a congenial home in Southern Maine, and this is written to call attention to it.

It can never become so bad a weed as its relative, the English Plantain, which has a strong foothold in some parts of Maine as it is an *annual* and could be eradicated in a single season if prevented from seeding. It may be known by the following description:

About a foot high, having usually several slender, naked, flowering stalks. which start from a cluster of leaves near the ground and bear on their top a close spike of flowers. The leaves are narrow, from three to five inches long, and bear a few nearly prominent parallel ribs. The variety under consideration is clothed with silky hairs and below each flower in the spike is a bract two or three times the length of the flower. The seed are boat-shaped as in the English Plantain. The seeds germinate the same season they ripen· and the young plants mature the next season. It seeds profusely and a few plants would give it a good start. That the plant may be readily detected we reproduce from the United States Agricultural Report, 1888, plate XI, a cut of this weed, which is shown on the opposite page.

ENTOMOLOGY.

The Angoumois Grain Moth.

(*Gelechia cerealella*, Linn.)

Order Lepidoptera: Family Tineidæ.

The above insect was detected the past season as detailed below. Experiments made by Mr. F. M. Webster show that the New England climate will not destroy this pest but only check its depredations during cold weather. His experiments also show that the pest can be destroyed by a temperature of 130° Fah. kept up for four or five hours. The accompanying cuts show the life history of this moth, and the nature of its work. Below we give an article upon this insect contributed to the *Maine Farmer* by the writer.

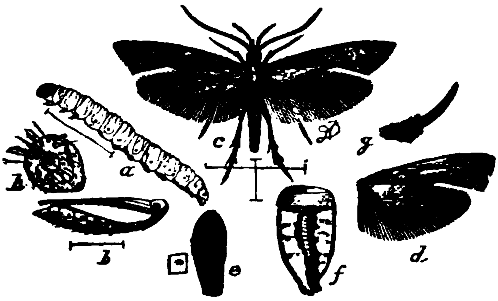


Fig. 5. Stages in the life history of the Angoumois Grain-moth, Gelechia cerealella, L.

Editor Maine Farmer: My attention was called a few days ago to the above insect found in great numbers in boxed Shaker rice pop corn, put up by R. H. Wright, Albany, N. Y., and obtained for retail in Orono from a wholesale house in Bangor. As this is one of the most destructive insects known to wheat, oats, barley and Indian corn, it seems desirable that attention be called to it. Upon opening the boxes swarms of full fledged moths were found on the top of the corn, and made their escape into the room. The kernels of corn each contained small circular holes, and the most of the starchy matter was eaten, leaving only the shell. Mixed with the corn were a large number of dead moths. The party who found the moths let the live ones from several boxes of corn escape in the store, and when I told him it was a bad pest, he said they would all die, as the store was cold nights, and that he had burned all the corn. Though this insect was introduced from France, and has done more damage South than North, yet it is undaunted by a cold climate, and would be capable of doing much damage in stored grain in Maine. This insect was abundant in the grain exhibits at the World's Fair the past season. To burn the corn after the moths had all escaped was useless. That this insect may be better known, so that precautions can be taken against it, we give the following regarding its life history:

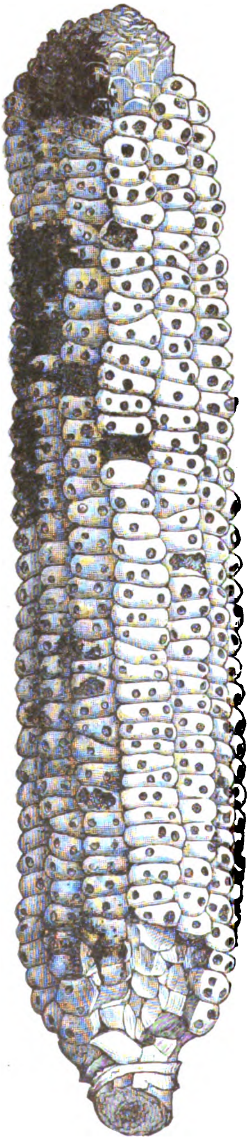


FIG. 6. Work of the Angoumois Grain-moth, Gelechia cerealella, L.

Perfect insect, a small moth with pointed wings, that spread between a half and three-quarters of an inch. Fore-wing pale shining ochre, with a grayish or brownish gray streak in the folds at the base, and a few scales of the same color toward the tip of the wing on the margin. Hind wings grayish ochre, and bearing a fringe of the same color on the border. *Larva*, a smooth, white worm, attacking the kernels, and consuming the inside, leaving the shell, and when full fed transforming to the *pupa* state in the grain, and finally emerging as a moth through a small hole in the kernel.

REMEDIES.

Bisulphide of carbon is now quite largely used to destroy insects infesting stored grains. In France they put the grain into an *insect* mill something like a peanut or coffee roaster, and raise the temperature of the grain high enough to kill the moths, eggs and larvæ. When the quantity of grain is small, it might be thrown into *hot water* or *heated*, and then fed to fowls. The work of this insect resembles in its effects that of the pea weevil, only the hole made by the moth is smaller, and so far as we know these insects never encroach upon each other's domain, the moth infesting the seeds of graminaceous plants, while the pea weevil is partial to legumes. Whether this corn was infested before it left the *Shakers*, or whether it lay in the wholesale houses in Bangor during the past summer, and was infested by moths of home production we do not know, but the moth is here *sure pop*, and we will have to look after it.

F. L. HARVEY.

ORONO, December 11th.

THE LIME-TREE WINTER-MOTH.

Hybernia Tillaria, Harris.

Order Lepidoptera: Family Geometridae.

Among some specimens of female Canker-worms received from Mr. F. W. Hilt of Warren, Maine, were several wingless females of the above species. The specimens were found on the side of a house where they had probably crawled to lay their eggs or meet the males. As the Canker-worm is very bad in Maine and as this insect has similar habits they should be distinguished.

DESCRIPTION.

Eggs pale yellow, oval and marked with a net work of raised lines. They can be distinguished from the eggs of the Canker-worm by their color and form. (See Experiment Station Report, 1888, p. 167, Fig. 20.) The eggs are laid in similar situations as those of the Canker-worm. As the females of both species had commenced to lay eggs in the box in which they were sent we concluded they were probably crawling up the side of the house to deposit the eggs.

Larva, when full grown, about an inch and a quarter long. Head dull red with a V-shaped mark on the front, yellow above and marked with many longitudinal black lines; the under side paler. Like the larva of the Canker-worm it is a *span* or *inch* worm but larger than the caterpillar of that species. The accompanying cut (Fig. 7) shows the larvae feeding and at rest.

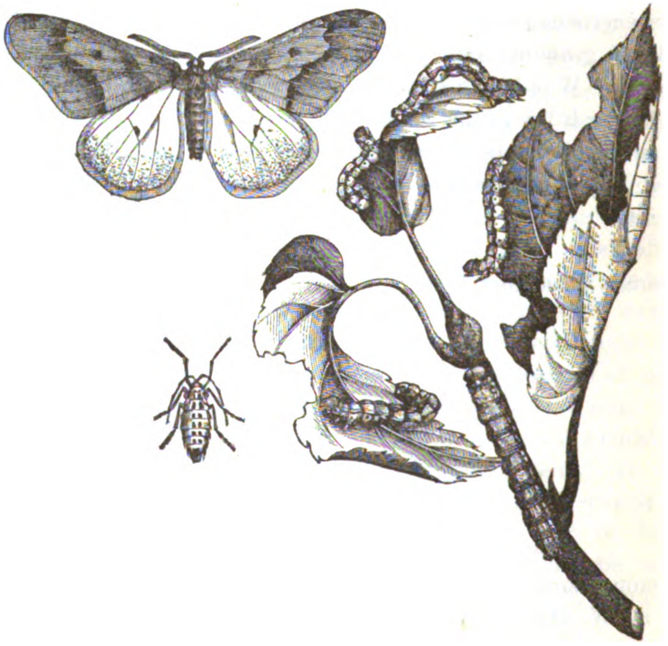


FIG. 7. The Lime-tree Winter-moth, Hybernia tiliaria, Harris. Male, wingless female and larvae.

Female Moth, wingless, spider-like, yellowish white, sides marked with black dots, each ring of the body, excepting the last, bears two black dots, which has only one. Head black in front and the legs ringed with black. Antennae thread like. Ovipositor jointed and retractile. The larger size, the spotted back and black rings on the legs readily distinguish this from the wingless females of the fall and spring Canker-worms. Fig. 7 shows the wingless female about natural size.

Male Moth, expanse of fore wings an inch and a half. Color, rusty buff sprinkled with brownish dots and with two transverse brown wavy lines, the inner most distinct. Between the bands and near the anterior edge is usually a brownish dot. Hind wings paler. Body color of fore wings The antennæ are feathered. Like most of the moths of the inch worms the wings are very delicate. The male moth about natural size is shown in Fig. 7. The moths of the Canker-worm would be on the wing at the same time but they are smaller.

LIFE HISTORY.

The eggs hatch early in the spring and the young larvae feed upon the foliage of the apple tree, basswood, elm, hickory, etc., and are full grown about the middle of June, when they usually let themselves down by a silken thread, enter the ground about five or six inches, form a little oblong cell within which they change to the chrysalis state. In October or November (sometimes not until the following spring) when the moths appear. The wingless females climb the trees or other objects where they meet the winged males, pair and soon deposit the eggs in clusters, (usually upon the branches of the tree they have infested,)completing the life history.

REMEDIES.

The life history of this species is so nearly like that of the Canker-worm that the remedies suggested for that insect are applicable to this. It has never done as much damage as the Canker-worm but it is capable of doing much injury to the foliage of apple trees and from the specimens received we should judge that it is quite abundant about Warren, Maine.

THE APPLE-LEAE BUCCULATRIX.

Bucculatrix Pomifoliella Clemmens.

Order Lepidoptera: Family Tineidæ.

We received from Mr. D. P Boynton, Monmouth, Me., a lot of apple tree leaves badly eaten by the larvæ of the above moth. In the box were quite a number of the larvæ and cocoons. This is the first time we have seen this species in Maine and as it is capable of doing considerable damage to the foliage of apple trees, we give the following account of it, so that it may be known and measures adopted to prevent it spreading.

HISTORY.

This moth was described by Clemens in 1860. It is known to be widely distributed having been reported from Texas, Missouri, Massachusetts, New York and now from Maine. It has done considerable damage to the foliage of apple trees especially in New York.

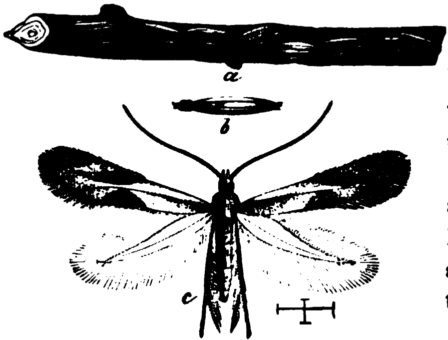


FIG. 8. The Apple-Leaf Bucculatrix. Bucculatrix pomifoliella, Clemmens. Moth enlarged, cocoons natural size and enlarged.

DESCRIPTION.

Eggs—So far as we know the eggs of this species have never been described. They must be quite small as the cocoons of this diminutive moth have been mistaken for insect eggs. They are said to be laid upon the leaves. We have never seen them.

Larva—About one-half inch long when mature, cylindrical, tapering at both ends. Joints of the body rounded and prominent, color dark yellowish with a greenish tinge, and reddish shades on the anterior segments. Body armed with short black hairs which are more numerous on the back of the first segment. Head small, brown and elipsoidal. The larvæ are active and when disturbed suspend themselves by a silken thread.

Cocoons—Dirty white, slender, about one-fourth inch long, ribbed longitudinally by about six prominent ridges, oblong, tapering and thinning at both ends, flattened on the side to which it is attached. Usually fastened to the twigs and branches in groups as shown in Fig. 8 a. Fig 8 b shows one of the cocoons enlarged. The specimens we had were confined in a box and the cocoons were attached to the leaves and side of the box. If it can be shown that in nature the cocoons are never attached to the leaves it would indicate a remarkable instinct, for if attached to the leaves which fall they would probably be destroyed, while attached to the twigs they would be safe during the winter. The cocoons contain the

Chrysalis which is dark brown, rough, punctured on the back, twelve hundredths of an inch long. When ready to transform the chrysalis works itself partly out of the cocoon and the moth comes forth.

Perfect insect a small moth that is only about one-fourth inch expanse of wings. Fore wings whitish tinged with pale yellow and dusty brown. On the middle of the inner margin is a conspicuous oval brown spot. A wide streak of the same color on the opposite margin which extends nearly to the end of the wing where it tapers and points to a small circular brown spot near the tip. The moth much enlarged is shown in Fig 8 c. The hair lines to the right show the natural size.

LIFE HISTORY.

This insect spends the winter in the chrysalis state in the cocoons usually attached to the twigs and branches of the host plant. There is reason to believe that the larvæ when full grown sometimes desert the host plant and form their cocoons on other plants close by. About the time the leaves unfold the moths come forth and lay their eggs upon the tender foliage. The larvæ are full grown in July. The specimens sent us in July were in the larval form and went into the chrysalis state in August and have not yet (January) emerged, which would indicate only one brood in Maine. Prof. Riley thinks there are two or three broods in the latitude of St. Louis, Mo. In the latitude of New York, Prof. Lentner states that there are two broods, one in July and one in September. Our specimens would belong to the July brood and possibly may be diseased and may not emerge. Possibly we have two broods in Maine. In September or October the cocoons are formed in which the pupæ spend the winter. The larvæ feed externally upon the foliage, at least the leaves we received had the upper epidermis and pulp eaten away in patches, the veins and lower epidermis intact.

REMEDIES.

Natural—This small moth is preyed upon by several parasites that attack the larvæ and hold the pest in check. Some of the cocoons probably suffer somewhat from inclemency of the weather. Possibly birds may eat them but we find no record of observations.

Artificial—(a) Jar the trees when the larvæ are full grown and they will suspend themselves by threads and can be swept down by a broom and killed by hot water or crushed.

(b) Apply kerosene emulsion with a spraying pump to the branches in winter that bear the cocoons. The same application might be made for the first brood when the foliage is on. Strong soap suds alone probably would kill them.

(c) If in small numbers the cocoons can be removed during the winter months by the hand.

The Disippus Butterfly.

Limenitis disippus, *Godt.*

Order Lepidoptera.

We receive the larvæ of the above species occasionally on account of the fact, that the second brood of larvæ hybernate when about half grown and make a beautiful hybernaculum that is sure to attract attention, also the larvæ is highly ornamented with colors and tubercles, and quite noticeable. The eggs are beautifully reticulated, small and laid on the under side of the leaf near the end. Most people are surprised to learn that those grotesque larvæ and odd hybernacula pertain to one of our common butterflies. Fig. 9 a shows the form of the full grown larvæ, b, the chrysalis, c, the hybernaculum in which the half grown larvæ of the fall

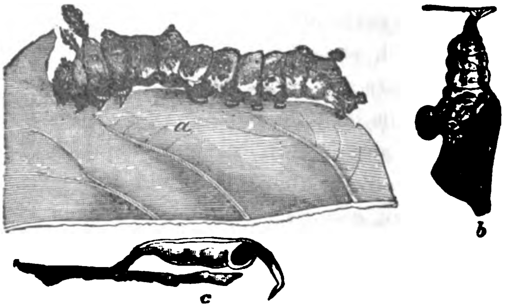


FIG. 9.

brood spends the winter. Fig. 10 shows the orange-red butterfly full size. The wings bear heavy black veins and a black border spotted with white.

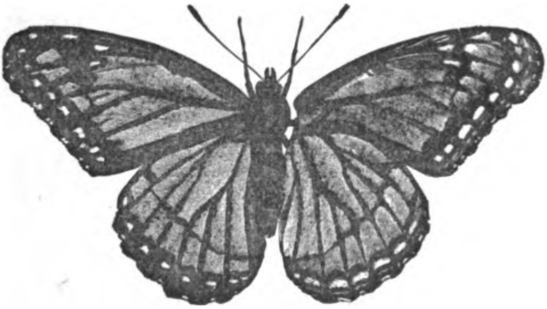


FIG. 10.

LIFE HISTORY.

The hybernating larvæ complete their growth go into the chrysalis state and the butterflies are on the wing by July. These deposit their eggs sometimes on the leaves of plums but usually upon willow or poplar. The eggs soon hatch and in a month the larvæ are full grown, enter the chrysalis state and in a short time the second brood of butterflies appear. These lay eggs which soon hatch and when the larvæ are less than half grown they make hybernacula from the leaves in which they spend the winter.

THE MAY BEETLE.

Lachnosterna fusca, (Frohl.)

Order Coleoptera: Family Scarabæidæ.

We received the following letter last September in reference to the above insert:

"BRIDGTON, Maine, September 18, 1893.

Professor Harvey:

DEAR SIR—I send you specimens of a worm that is doing a great amount of damage to the farms in this vicinity. There are many acres of grass land in this town where a good crop of Timothy was cut the present season which now show hardly a green blade of grass. These worms are found just below the surface where they feed upon the roots of Timothy. Can you tell us the name of the worm, its habits and if there is any way of extermination or curtailing its ravages? Will you please answer at once as we wish to find out how to treat the land this autumn.

"An early reply will greatly interest many farmers in this section of the State. Respectfully, J. L. WALES."

In response we sent Mr. Wales what information we had regarding the methods of coping with this pest. Mr. Wales published a newspaper article on this insect from which we make extracts to show the extent of the ravages of this insect in the State.

WHAT SHALL BE DONE WITH THE "WHITE GRUB"

This is becoming a very serious question with many farmers and gardeners at the present day in the town of Bridgton and vicinity.

A few days since Mr. A. M. Thomes, the owner of a nice farm on High street invited me to visit his grass fields. In one corner of a fine, large field which had borne a heavy crop of Timothy the present season, we found rather more than a half-acre upon which there was not visible a sign of vegetable life. What had composed the turf or sward could be stripped off and rolled up like a carpet, leaving the soil naked and brown and bringing to light upon each square foot of surface from a dozen to twenty flat white grubs. Several of these were put in alcohol and sent to Prof. F. L. Harvey of the State Agricultural College at Orono, who kindly and promptly sent what information he had at hand relative to the name, habits, and remedies, for this pest of the farmer. The grub especially loves to feed upon the roots of Timothy or herds grass, as may be seen upon the farms of Mr. Thomes, M. B. Stone, Nathan Palmer, Geo. Hilton and many others; it also loves the roots of the strawberry. Mr S. E. Lee of High street lost about one thousand fine strawberry plants the present season. The roots of corn are often devoured by the grub as may be seen on the farm of Mr. Geo. Chaplin, Naples Mr. John Palmer of South Bridgton lost a part of his potato crop in the same way.

Complaints from other parties and from other sections of the State show that the "White Grub" is wide spread and doing much damage in the State.

This insect is so familiar to everybody that we will take space to give an account of its life history but publish herewith a cut so as to show clearly what insect is meant. Figure 11. 1 shows the pupa, 2 the grub, 3 and 4 side and dorsal views of the beetle. This insect is known as the "May Beetle," "June Bug" and "White Grub." In the larvæ state it feeds upon the roots of plants having done much damage to grass lands and especially to strawberry vines The beetle feeds upon the foliage of trees and where· abundant often entirely stripping them of their leaves. The beetle is attracted by lights and is a frequent evening visitor to our living rooms while on the wing. The impression prevails that the eggs are laid on grass near the roots though perhaps this matter may bear further study.

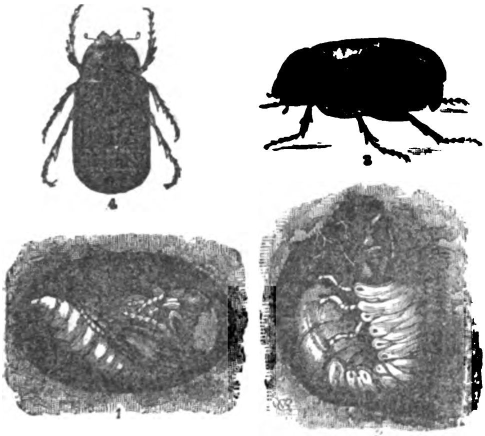


FIG. 11. The May Beetle. Lachnosterna fusca, (Frohl.) 1 pupa, 2 larvæ, 3 and 4 Beetle.

REMEDIES.

The Department of Agriculture at Washington, D. C., has conducted some experiments to show that kerosene emulsion liberally applied to the soil infested with "white grubs" will destroy them. The remedy would be too troublesome and expensive for application in large meadows but for small areas is worthy of trial. We extract the following from Prof. Riley's letter regarding the subject: "The application of kerosene emulsion for white grubs is impracticable over very large areas owing to the necessity of washing the emulsion into the soil to considerable depth by a copious application of water, unless the application can be made with tolerable certainty of its being followed by slow and continuous rains such as will carry it into the soil gradually without washing it away. These conditions will not often be available at the time wanted, but for all limited applications as to lawns or limited patches of ground affected by the larvæ, there is no better remedy than the kerosene emulsion treatment. I have no accurate data as to the amount required per acre but if the emulsion is applied sufficiently to thoroughly wet the surface of the soil to the depth of an inch or more and then carried down by applications of water to a depth of about eight inches during the next two or three days, the treatment will certainly prove effective. The amount necessary will vary with the different soils, both of the emulsion and the water applied later on to carry it down, easily permeable, sandy soils requiring less than denser clay soils.

Professor J. B. Smith has found potash fertilizers in the form of *Kainit*, applied as a top dressing efficacious against root affecting insects, such as wire worms. We wrote Professor Smith regarding the matter and below is his reply.

NEW BRUNSWICK, N. J., September 22, 1893.

DEAR SIR—Your card of the 20th inst., is at hand. The latest on Lachnosterna you will find in Forbes' 17th Illustrated Report, issued in 1891. I have had no personal experience with these insects from the economic side, and cannot give you any positive or tried suggestions. You know my hobby, and if the matter came to me in New Jersey, I would advise heavy top dressings of Kainit and Nitrate of Soda applied in combination after the flight of the beetles is over in spring, or the former alone applied early in September. Yours very truly, JOHN B. SMITH.

Professor F. L. HARVEY, Orono, Maine.

Mr. Wales in his article suggests the following: "In the days of our fathers when the 'burnt pieces' were lighted up at night time by the partially extinguished fires, the farms and orchards were not infested by so many hostile enemies; and would not fires kindled in the neighborhood of orchards for a few evenings in late May or early June destroy the beetles and thus prevent the production of the white grub?"

The rooting propensities of swine can be put to practical account in destroying this pest. If I had meadow land on which the sod was dead and could be rolled up like a carpet, I would construct a movable fence and enclose the small areas and turn in a few hogs. The land would have to be reseeded and the swine could do no damage, and they would probably devour a large number of the grubs

Skunks and crows are known to be enemies of the "white grubs" but owing to the demand by furriers for the pelts of the former and our anti-crows law against the latter we have not much to hope for in those directions.

We hope the farmers whose fields are infested will try some of these measures. There is one consolation and that is the life history of this pest is completed in three years and it would not probably lay its eggs on the same ground again, but seek some new field of conquest.

THE BEAN WEEVIL.

Bruchus obtectus, Say.

Order Coleoptera: Family Bruchidæ.

We received specimens of beans infested by the above insect from Hon. Samuel Libby, Orono. He gives the following interesting history regarding them: "The beans are of the horticultural variety and were gathered in the pods when ripe in September, 1891, and taken to my store where they lay until October, 1891. I then sorted out those that had six beans in a pod for seed and also those with five beans in a pod for second choice. The lot having five beans in a pod were put in an open basket in the store. They remained there during the summer of 1892 and about January 1, 1893 I had occasion to examine them and found they were infested. About one-tenth of the pods had holes in them and I found fine dust falling from the beans, and saw the holes in them. I also noticed small black objects in the basket. Not knowing that there was a bean weevil that worked on beans as the pea weevil does on peas I laid them aside for you.

The pods having six beans in them were shelled and planted in the spring of 1892 and showed no signs of weevil work. I have grown horticultural beans for twenty years and have always raised my own seed. In 1891, 4, planted beans obtained elsewhere and the beetle might have been introduced with that seed. "The crop of 1892 shows no evidence of weevil work."

We examined the specimens submitted and found them to be *Bruchus obtectus*, Say. The beans contained eggs; minute larvæ just hatched; larvæ one-third, one-half and full grown; pupæ in various stages of development; full grown pale colored beetles; some full colored ready to emerge; others free in the basket alive and some apparently dead. There were as many as twenty individuals in some of the beans. There were numerous holes in some of the beans from which the beetles had escaped, also many oval translucent places where the coating of the bean had been made thin by the beetles indicating their location within. The inside of some of the beans was completely eaten and only the powdery excreta remaining. We wish to add our testimony to that of Popenœ, Schwartz and Lintner that successive generations of this insect occur in stored beans, and also that if the food supply does not become exhausted they may survive into the *second season.* They will eat cotyledons, radicle and plumule. Several specimens showed the cotyledons entirely detach from the radicle and it intact. We believe the radicle is rejected not because it is less desirable for food but on account of it being small and nearly isolated from the bean mass. We found one specimen with the cotyledons nearly intact and the radicle eaten, its place being occupied by a well fed larva. In some specimens *nothing* remained excepting the seed coats filled with powdery excreta.

It has not been clearly shown that the beetles will not fly or crawl to new lots of stored beans and infest them.

Or in other words it is not known whether beans may become infested after they are stored by the beetles laying their eggs upon them. The general belief is that the beetles confine their attacks to the lot of beans infested and that they spread during the summer through the agency of eggs laid on the growing pods.

Prof. Lintner has shown that the beetles will lay their eggs upon dry beans and that in the infested lot that the young larvæ will gnaw into them and perfect themselves.

The fact that a part of the lot of beans which Mr. Libby took to his store was not infested when shelled the next spring would lead one to suspect that the others may have been infested by beetles getting into them after they were stored. The holes in the pods may have been made for the entrance of beetles as well as for their exit. The holes being in the pods shows that the beetles as well as the larvæ have adequate gnawing powers. The only thing that would prevent infection this way would be the sluggish habits of the beetles. Those we had in a warm room in January were quite active. They did not fly but crawled rapidly. Prof. Lintner's observations show clearly that they may spread from the beans originally infested in a lot to the others stored with them. It is also important to know whether the beetles that mature at all seasons of the year may not fly to new lots of stored beans and infest them.

The fact that successive generations occur in stored beans; that sound beans in the same lot may become infested and that possibly new lots may also become infested, makes this weevil a more formidable pest than was formerly supposed.

Beans are largely grown and consumed in Maine and should this insect become common much damage might be done. Below we give its history, characters and remedies.

HISTORY.

This species is probably not native but was introduced as early as 1860, at least, possibly from *Asia*. It would seem that it has erroneously been considered the same as *B. obsoletus*, Say., bred from *Astragalus* seeds from Indiana as early as 1831. This view is strengthened by the fact that it was found in 1876 at Philadelphia in beans from various countries from both continents. At present it is cosmopolitan. It was first noticed in Rhode Island in 1860 by Dr. Fitch, who described it as *Bruchus Fabæ*. Within the next ten years it was carried to nearly all parts of the United States. In 1870 it was known from several of the New England States. So far as we know it has not previously been reported from Maine. Professor Fletcher has not found it in Canada. As the beetles are sluggish and disinclined to fly it is mainly distributed in infested beans. Those wishing a fuller consideration of this insect will find an interesting summary of the facts known regarding it in Professor Lintner's 7th Report of the Injurious and Other Insects of the State of New York, p. 255.

Characters—A small beetle that would be usually found infesting beans or associated with them. See Fig. 12. There are two closely related species of *Bruchus* that have been found infesting beans in this country. The above species is by far the most

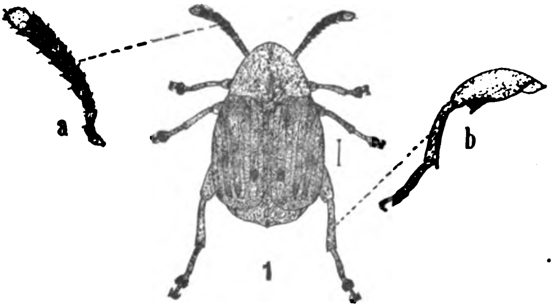


FIG. 12. Bean Weevil, much magnified.

common. It is one-tenth of an inch long, oval in form, head bent downward and more or less concealed from above, prolonged into a short, squarely-cut beak. Antennæ distinctly jointed, enlarged at the tip, the four basal and the terminal joints reddish or yellowish. Thorax and abdomen about the same width where they join. Wing covers marked by ten impressed and punctured lines in flattened ribs, which are clothed with a short pubescence, arranged in yellowish, black and whitish spots and lines—the white lines more distinct on the third rib. The abdomen is pale, dull yellow, with a black band on the fore part of each joint. It projects beyond the wing covers and that part is obscure grayish with a faint, medium whitish stripe. The hind thighs near their end armed with a long and two short spines. Feet reddish.

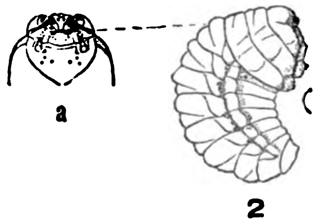


FIG. 13.

The larvæ are white and broadly oval, see Fig. 13. The eggs white, thicker at one end and about three times as long as wide.

The work of this insect appear on the surface of the beans as small holes from which the beetles have escaped, and small oval, translucent spots on the surface over the cells that contain bettles that have not emerged. The work is shown in Fig. 14. The inside of the bean in badly infested specimens is entirely converted into a powdery mass of excreta. Often the beans will contain larvæ in various stages of growth and also beetles. Fig. 15 shows the pupa. Fig. 16 shows the closely related Pea Weevil, enlarged and natural size, which is given for comparison.

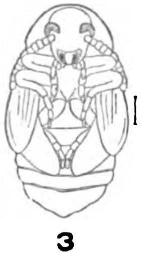


FIG. 15. Bean Weevil pupa.

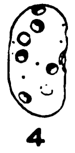


FIG 14. Bean Weevil. Work of the insect.

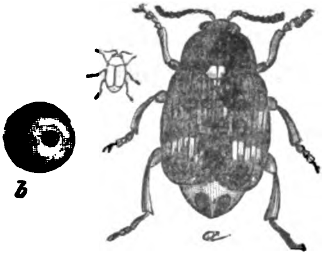


FIG. 16. Pea Weevil. a, natural size and enlarged; b, work of the insect.

LIFE HISTORY.

The eggs are laid upon the young bean pods after the flowers have withered, at any point, and sometimes many on a pod. The eggs hatch in a few days and the young larvæ enters the growing bean. It lives upon the substance of the bean making an excavation somewhat larger than itself in which it transforms to the pupa, finally to the beetle state. The beetles may emerge in the fall or at any time during the winter, lay eggs, which hatch and the larvæ enter the same beans or new ones. Successive generations may occur until the food supply is exhausted. Those beetles on the wing during the summer lay their eggs in the pods of the growing crop. The length of time required for the transformations has not been studied but probably is variable with circumstances. We found quite a number of dead beetles within the cells in the beans.

PRECAUTIONS

Experiments have shown that beans infested with *weevils* will not all sprout and that the plants from them are sickly and do not produce a full crop. It is therefore best not to plant them. It is believed upon good authority that beans containing the weevils in the beetle form are probably injurious and unfit food for man or beast.

REMEDIES.

If beans are found to be badly infested so as to be useless for food or seed, they should be *burned at once* so as to prevent the escape of the beetles.

Beans should be kept in a tight box or bag and any beetles that escape in the bag destroyed.

Throw the infested beans into hot water. (The exact amount of heat that beans will stand and germinate is not known but experiments would determine.) We feel sure the germ will stand more heat than the weevils.

Prof. Weed killed pea weevils by exposing the peas to a temperature of 145° F. for an hour. Bean weevils probably could be destroyed in the same way.

Probably the best way is to put the beans into a tight box and fill it with the vapor of *Bisulphide* of *Carbon* and leave it for two or three days. Bisulphide of Carbon is *very inflamable* and no light should be brought near it.

Experiments show that infested beans lack in vitality and when good seed can be had it is best to procure it and not run the risk of perpetuating the pest and growing a crop of weakened plants.

THE PEAR-BLIGHT BEETLE, OR SHOT-BORER.

Xyleborus pyri, Peck=*X. dispar, Fbr.*

Order Coleoptera: Family Scolytidæ.

Last summer we received some small apple tree limbs from Professor Munson for examination. They were handed to him by Mr J. N. Allen, North Sedgwick, Me. We obtained the same insect from Dr. Twitchell about the same time from the vicinity of Augusta. These limbs were literally honey-combed with small channels that extended through the liburnum and heart wood to the centre. The exit holes through the bark were .06 to .08 of an inch in diameter and nearly circular, looking like small shot holes. The wood was green showing that the insect attacks the growing tree. Living wood does not appear to be essential to the life and comfort of this species, for after a period of several weeks we found in a limb that had been in a dry place in a box, young larvæ, full grown larvæ, pupæ and perfect beetles. We put a portion of a small limb (2 inches by 3 inches) in a box and allowed the pupæ to transform and in the fall we found fifty beetles had emerged.

We wrote a short account of this insect at the time for the *Maine Farmer* and called it *Xyleborus pyri*, Peck, the Pear-blight Beetle. To be absolutely certain we sent some specimens to Mr. A. H. Hopkins, Morgantown, West Virginia, who has given special attention to the *Scolytids* and he sent the following reply:

"The beetle you sent is *Xyleborus pyri*, Peck=*X. dispar*, Fbr. This species is quite common in West Virginia, but strange to say, I have never met with it in apple or pear trees. I find it in hemlock, beech, birch and oak. I have specimens of X. dispar from

Germany and though I can detect a slight difference between the females of the European and American form yet there is not difference enough to separate them as distinct species." We have seen this beetle in abundance in juniper about Orono and we have no doubt that it has transferred its depredations from adjacent forest to the orchards. Professor Fletcher reports its increase in Nova Scotia.

Below we give a description, the life history and suggestions for the treatment of this beetle.

DESCRIPTION.

So far as we know the eggs have not been described. They must be very small and are said to be laid at the base of the buds. We have never seen them. The young larvæ bore into the wood making deep channels which in small twigs interfere with the circulation of the sap, and the twigs wither giving the appearance of blight, hence the name PEAR-BLIGHT BEETLE. The work of this beetle should not be confounded with the Pear-blight proper which is caused by a species of bactaria. When the larvæ are full grown they transform to pupæ in the burrows and finally emerge as small beetles about one-tenth of an inch long and of a dark brown or nearly black color, with the antennæ and legs of a rusty red. The thorax is short, very convex, rounded and roughened. The wing covers are marked by longitudinal rows of punctures. The hind part of the body slopes abruptly. The beetle natural size and enlarged are shown in Fig. 17. The beetles leave their burrows in July and deposit eggs before August.

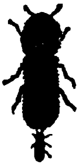


FIG. 17. Pear-blight beetle. Natural size and enlarged.

REMEDIES.

As these beetles work wholly under the bark they cannot be reached by insecticides. The only way is to watch the trees during the latter part of June and July and if blighted twigs or diseased limbs are noticed examine the branches for small pin holes and if found the presence of this or some related species may be suspected. The diseased limb should be cut *at once* below the injury far enough to nclude all the burrows, and *burned*, for the beetles will transform, emerge and attack new trees. As these beetles live in forest trees orchards near timber would be more likely to become infested.

CARROT FLY—CARROT RUST FLY.

Psila rosæ, Fab.

Order Diptera:

We received the following letter from Mr. Morrell which was accompanied by the *larvæ* and pupæ of a species of fly, also pieces of carrot in which the maggots had been working.

"PITTSFIELD, MAINE, April 6, 1893.

Professor F. L. Harvey:

DEAR SIR—I send little worms which I would like to have you identify. The worms are in our carrots and have made holes all through them. after the manner of those in the piece I send. The carrots were placed in a barrel and the barrel filled up with fine dry sand like that I send. On sifting the sand I find it full of worms. Beets grown side by side with the carrots, and packed in the same kind of sand have no worms. Very truly,

C. H. MORRELL"

Not recognizing the species we wrote Mr. Morrell that the specimens were the larval and pupal stages of a fly that we would have to transform and obtain the flies before identifying it. The infested material being only a barrel of sand and this very fine we suggested sifting it to remove the pupæ and larvæ that had left the carrots to transform and burning the siftings; or heat the whole material with hot water. We received the following reply accompanied with fully *two hundred* pupæ and larvæ.

"PITTSFIELD, MAINE, April 11, 1893.

DEAR SIR—Your card received. For the information, thanks. I have sifted part of the sand and burnt the siftings, and put the rest in boiling water. I don't believe those insects will do any more harm. 'I send another box of them as you requested.

Very truly,

C. H. MORRELL."

After having reared the flies we wrote Mr. Morrell as follows:

"ORONO, MAINE, May 26, 1893.

Mr. C. H. Morrell:

DEAR SIR—I have reared the flies from the pupæ and larvæ, which were affecting your carrots, and am now able to state that it is the "Rust Fly" or "Carrot Fly" an *imported* species from *England*, which has been giving some trouble since 1886 in Canada but so far as I know has *never* before been reported from the United States. It is regarded as a very troublesome insect abroad and its introduction here is certainly unfortunate. I am at a loss to suggest how it reached your locality, and will be pleased if you can give me any help in the matter. Have you noticed it before in your place? Please ascertain whether your neighbors have noticed it. Have carrots been imported to your locality, if so, from where? You better watch your carrot bed this season and if the leaves of the young plants turn brown, examine the young roots for the brown rust spots on the surface and the interior for the maggots. If you find them, then after thinning, sift sand saturated with kerosene between the rows, and water heavily to pack the dirt close to the roots so the flies cannot crawl down to lay their eggs.

Respectfully, F. L. HARVEY."

We put the larvæ and pupæ sent by Mr. Morrell into sand in a breeding cage and in about two weeks the flies began to emerge in abundance and continued to come out for two weeks. We transferred some males and females to a jar containing parsnips, as we were not able to get carrots. In a day or two we noticed the females crawling between the leaves and going down to the base of them and though we had not observed them mating presumed they were ovipositing. The next day we broke off a leaf and found the eggs near the base laid on the surface in small clusters and loosely attached to the surface of the leaf. Having now eggs, larvæ, pupæ and flies we made out the following description:

Eggs—.6 mm. long (.024 in.) by .115 mm. broad (.0046 in.) white, oblong, about five times as long as broad, longitudinally marked from end to end by about 10 ridges and furrows which are from centre to centre .022 mm. The furrows between the ridges are marked by about thirty circular pits. The sculpture resembles the surface of a peanut. At one end the egg abruptly narrows and bears an oblong pedicil, twice as broad as long, and one-third the width of the egg at the widest part, (.022 mm. x .044 mm.) The pedicilate end of the egg reminds one of a tied grain sack. See Fig. 18.

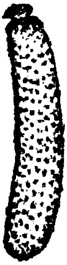


FIG. 18.
Egg of Psila rosæ × 50 times. (Original.)

Larvæ—6 mm. long, (.25 in.) breadth 1 mm., (.04 in.) legless, white or pale yellow, semi-transparent, head end quite pointed and armed with a pair of black hooks for gnawing. Aboral end blunt, obliquely docked and bearing on the face of the oblique portion the dark colored caudal spiracles. Third segment from the last longest and somewhat longer than the last two. The sutures between the segment deep. The segments somewhat transversely wrinkled. See Fig. 19.

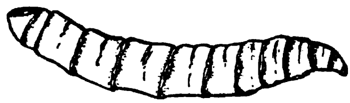


Fig. 19. Psila rosæ. Larva × 8 times (original.)

Pupæ—5 mm. (.20 in.) long, 1.25 mm. (.05 in.) wide, coarctate, brown,obliquely docked behind. The docked portion bordered by a rim and bearing two black tubercles. Fig. 20 shows dorsal and side views. The form of the pupæ is quite variable. Some have two tubercles at the head end and the black candol spiracles show on the oblique end. Some have the sides parallel while others are quite fusiform. The surface is quite wrinkled. Some are fully a fifth longer than others.

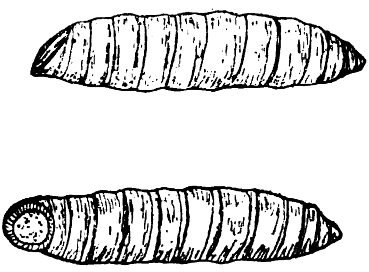


Fig. 20. Psila rosæ. Pupæ × 8 times (original.)

Flies—Length 6 mm. (.25 in.) Wings 3 5 mm. long (14 in.) and extending nearly half their length beyond the abdomen, thin and iridescent. Abdomen and thorax shining pitch black clothed with short grayish pubescence. Head pale orange or yellowish; eyes dark brown; Antennæ basal joint general color of head, terminal joint nearly black, bristles light. A spot above the mouth black, palpi black, proboscis very prominent, oblong and armed with many short hairs. Legs pale yellowish brown. Abdomen ovate. Scutellum raised and bearing two bristles. Arista armed with short hairs. About eight bristles on the mesothorax. The flies have the habit of opening and closing the wings, which are quite iridescent in the sunlight. The males are smaller than the females. Fig. 21 shows the form and veining of the wing. If the veining of the wing s o *Psila rosæ* are correctly shown in the small cut in United States Agricultural Report, 1893, p. 133 then serious doubt arises regarding the determination for the veining of the wings of our specimens are quite different. Probably in so small a cut accuracy was not considered essential.

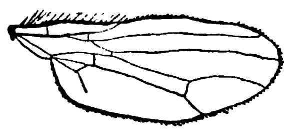


Fig. 21. Psila rosæ, wing × 10 (original.)

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ANNUAL REPORT

OF THE

MAINE STATE COLLEGE

FOR THE

YEAR 1894.

PART II.

PART I–Reports of Trustees, President and Treasurer

PART II–Report of the Director of the Agricultural Experiment Station.

ANNUAL REPORT

OF THE

MAINE STATE COLLEGE

FOR THE

YEAR 1894.

PART II.

Report of the Director of the Agricultural Experiment Station.

AUGUSTA:
BURLEIGH & FLYNT, PRINTERS TO THE STATE.
1895.

MAINE STATE COLLEGE.

AGRICULTURAL EXPERIMENT STATION.

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ANDREW M. SHAW	Foreman in Experimental Agriculture
MRS. J. HAMLIN WAITT	Clerk and Stenographer

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*Died February 26, 1894.

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TREASURER'S REPORT.

The Maine Agricultural Experiment Station in account with the United States appropriation:

RECEIPTS.

From the Treasurer of the United States as per appropriation for the year ending June 30, 1894	$15,000 00

EXPENDITURES.

Botany and Entomology	$ 25 35	
Chemical Laboratory	215 13	
Expense Account	144 94	
Field and Feeding Experiments	757 04	
Horticultural Department	925 92	
Meteorology	107 02	
Printing	1,397 65	
Construction and Repairs	749 19	
Stationery and Postage	160 80	
Traveling Expenses	226 34	
Library	226 99	
Veterinary Science	52 26	
Fuel	94 40	
World's Fair	16 06	
Heating Apparatus	1,020 91	
Water Supply	150 00	
Salaries	8,730 00	
		$15,000 00

I hereby certify that the above is a correct statement of the amount expended by the Maine Experiment Station for the year ending June 30, 1894.

G. H. HAMLIN, TREASURER,

Trustees of Maine State College of Agr. and the Mech. Arts.

I hereby certify that I have examined the accounts of the Maine Experiment Station for the fiscal year ending June 30, 1894; that I have found the above to be a correct statement of expenditures both as to amount and classification, for all of which, proper vouchers are on file.

HENRY LORD, AUDITOR,

Trustees of Maine State College of Agr. and the Mech. Arts.

DIRECTOR'S REPORT.

A. W. Harris, D. Sc., President Maine State College.

SIR:—I have the honor to submit herewith the report of the work performed by the members of the Experiment Station Staff during the year 1894.

It will be observed that the size of our report for 1894 is no larger and perhaps not so large as those of some previous years. This fact calls for explanation. It is due to several reasons.

1st. All of the work performed in 1894 is not reported. None of the data resulting from the investigations now being conducted in the line of plant nutrition have been published since those secured in the spring of 1893. As this work has consumed much time both in the laboratory and forcing house, its omission from the report has quite a material effect upon its size. Again, an experiment in animal nutrition which has now been continued for over eighteen months has received no mention. The object in withholding these data is that more completeness and definiteness may be secured in the conclusions which we hope to reach.

2nd. The data of our experiments and investigations are not published with that fullness of detail that is sometimes the practice. These details have a permanent record; but it is deemed wise not to confuse those who consult our reports with a large mass of figures and observations that serve to bewilder the reader.

3rd. Considerable of the time of one of the Station chemists was occupied with analyses of samples of suspected butter as an aid to the attempt made by Secretary McKeen to prevent the illegal sale of imitation butter. The attendance of myself and Mr. Bartlett was also required at court several times. The results so far secured seem to have justified the aid given. It is plain that the dairy interests of the State have in this way been materially aided.

REARRANGEMENT OF DUTIES.

The death of Professor Walter Balentine, who had the immediate charge of certain lines of Station work, and the consequent election of myself to the position which he occupied, have led to a partial rearrangement of the duties of some members of the Station Staff. I have undertaken the supervision of the field experiments which were under Professor Balentine's care, and the duties of the Station chemists, Mr. Bartlett and Mr. Merrill, have been enlarged by associating them with the immediate care of the experiments and investigations in plant and animal nutrition, work that previously was entirely superintended by Professor Balentine and myself.

SCOPE OF STATION WORK.

In order that the numerous directions along which the activities of the Station Staff are employed may be clearly seen, I summarize below the lines of work to which we are giving attention.

I. Experiments and investigations.
  (a) in plant nutrition,
    (1) Forcing house experiments,
    (2) Field experiments.
  (b) in animal nutrition,
    (1) Digestion experiments,
    (2) Animal growth,
    (3) Milk production.
  (c) in horticulture,
    (1) Plant breeding,
    (2) Cultural experiments,
    (3) Prevention of plant diseases and pests.
  (d) in economic botany and entomology,
    (1) Weed pests,
    (2) Injurious fungi,
    (3) Injurious insects.
  (e) Bacteriology and veterinary science.
II. Creamery management.
III. Work of inspection.
  (a) Official fertilizer control.
  (b) Inspection of butter samples.
IV. Special analyses.
V. Correspondence.
VI. Institute work.

CORRESPONDENCE.

The amount of correspondence is steadily increasing year by year, and a large amount of time must be used in giving careful replies to the numerous inquiries which we receive concerning a great variety of subjects. The correspondents of the Station do not always receive prompt attention because of the absence at institutes or other work of the person who can give the desired information.

SPECIAL ANALYSES.

Very many requests are made each year to have analyses made of fertilizers, foods, minerals, drinking waters, etc., etc. Some of these requests are granted and others are refused. The reasons for the refusals are various. Sometimes the desired information can be given without analysis. The samples of fertilizers are often from those brands that have had recent inspection and additional analyses are not necessary. Examinations of drinking water are invariably refused as they are not considered as coming properly within the scope of our work. Besides being time-consuming, a mere chemical analysis of a drinking water settles nothing as to its healthfulness, in most cases, and with the additional bacteriological tests which are necessary in order that the results may have a definite value, would seriously interfere with duties that are mandatory.

INSTITUTE WORK.

The members of the Station Staff have freely participated in the institutes held under the auspices of the Board of Agriculture. While this work requires something of a sacrifice of effort, especially on my own part, it is felt to be necessary and profitable. Moreover, a failure to aid in these institutes to the extent that is acceptable would be a poor return for the cordial and helpful attitude which the Secretary of the Board and his associates have taken towards the Station.

PUBLICATIONS.

During the year the Station has issued eleven bulletins, two of which were reports of the inspection of fertilizers, and the others summarized briefly such reports of Station work as admitted of reliable conclusions. Ten thousand of each bulletin are now printed, nearly all of which are distributed in Maine.

Respectfully submitted,
W. H. JORDAN, *Director*.

MAINE STATE COLLEGE,
ORONO, ME., December 31, 1894.

ACKNOWLEDGMENTS.

Acknowledgment is hereby made for the following gifts to the Station:

One Wagner's Dairy Pipette.

As the result of a correspondence with Mr. Bartlett several firms presented to the Station Babcock Milk Testing Machines. These have been placed in the Dairy Building in order that dairy students may have access to them.

Steam Turbine Tester, Stoddard Manufacturing Co., Rutland, Vt.

Two Ten Bottle Hand Machines, Vermont Farm Machine Co., Bellows Falls, Vt.

One Ten Bottle Hand Machine, Cornish, Curtis & Greene, Fort Atkinson, Wis.

The following donations have been made to the Horticultural Department, 1894.

J. J. H. Gregory & Son, Marblehead, Mass., vegetable seeds.
Charles A. Miller, East Union, Me., apple cions.
John Nichols, North Searsport, Me., apple cions.
Division of Pomology, Washington, D. C., apple cions.
R. C. Buckley, Peoria, Ill., Buckley Wheel hoe.
Lucian Saunderson, New Haven, Conn., Comet Bug Killer.

The following newspapers and other publications are kindly donated to the Station by the publishers during 1894:

Farmers' Home, Dayton, Ohio.
Holstein Friesian Register, Boston, Mass.
Farm and Home, Springfield, Mass.
Jersey Bulletin, Indianapolis, Ind.
Farmers' Advocate, London, Ont.
Maine Farmer, Augusta, Maine.
Southern Cultivator, Atlanta, Ga.
American Dairyman, New York, N. Y.

The Sun, Baltimore, Md.
Massachusetts Ploughman, Boston, Mass.
Practical Farmer. Philadelphia, Pa.
New England Farmer, Boston, Mass.
Louisiana Planter, New Orleans, La.
Mirror and Farmer, Manchester, N. H.
Texas Farmer, Dallas, Texas.
Hoard's Dairyman, Fort Atkinson, Wis.
Detroit Free Press, Detroit, Mich.
Orange County Farmer, Port Jervis, N. Y.
Farm Journal, Philadelphia, Pa.
Delaware Farm and Home, Wilmington, Del.
American Cultivator, Boston, Mass.
Farmers' Review, Chicago, Ill.
The Rural Canadian, Toronto, Ont.
Vick's Magazine, Rochester, N. Y.
The Farm and Dairy, Ames, Iowa.
The Clover Leaf, South Bend, Ind.
The Grange Visitor, Lansing, Mich.
The Industrial American, Lexington, Ky.
The American Grange Bulletin and Scientific Farmer, Cincinnati, Ohio.
Agricultural Epitomist, Indianapolis, Ind.
Northern Leader, Fort Fairfield, Me.
American Agriculturist, New York.
American Creamery, Chicago, Ill.
Vermont Farmers' Advocate, Burlington, Vt.
The Farmers' Magazine, Springfield, Ill.
The Dairy World, Chicago, Ill.
The Rural New Yorker, New York, N. Y.
The Homestead, Des Moines, Iowa.
Turf, Farm & Home, Waterville, Me.
The Elgin Daily Reporter, Elgin, Ill.
The Dairy Messenger, Winnetka, Ill.

PARTIAL REPORTS OF THE CHEMISTS.

ANALYSIS OF BUTTER AND IMITATION BUTTER.

J. M. Bartlett.

The following work on butter and imitation butters was performed for the Secretary of the Board of Agriculture to assist him in enforcing the oleomargarine law for the protection of the dairy industry.

The samples were taken by himself or his agent and then turned over to the Station for analysis. As some creameries were accused of mixing butterine or oleo with their product, a few samples of their goods were taken from the open market for examination but no adulteration was detected. Several of the parties selling the imitation article illegally were prosecuted, brought to trial and convicted. These trials necessitated the chemist spending several days at court. The results of the analysis are shown in the following table.

In most of the samples only the volatile fatty acids were determined, those being the only ingredients present in fats of the butters or butterines, that vary sufficiently to show the source from which the fat is derived. The results for volatile fatty acids are expressed in cubic centimeters of one-tenth normal alkali. Those contained in five grams of pure fat from milk or cream requires 25. to 34. c. c. one-tenth normal alkali to neutralize them, while those from other sources, such as lard, tallow, etc., require less than 4 c. c. The melting points are of considerable interest and it will be seen that with the exception of three or four samples, butterine has no higher melting point than good creamery butter.

Laboratory number.		Water.	Salt and ash.	Caseine and other organic matter.	Fat.	Volatile fatty acids. c. c.	Melting point c.
	S. B. Creamery butter	12.1	2.63	.95	84.32	31.85	34.6
	F. C. Creamery butter	12.3	1.93	.93	84.84	30.8	34.2
	L	12.6	4.35	.98	82.07	32.78	34.4
401	XX. Imitation butter	9.06	3.15	.66	87.13	0.8	35.25
402	000	11.46	4.50	1.05	82.99	1.5	34.4
403	L. & W	10.85	4.49	1.12	83.54	1.25	33.1
404	XXX	9.44	3.25	.69	86.62	1.45	34.8
405	10 lbs	7.9	4.3	1.6	86.2	1.5	36.8
406	K. B	9.5	4.30	.98	85.22	1.6	
407	B. B. Dairy butter	-	-	-	-	31.25	
408	c. c. Dairy butter	-	-	-	-	31.4	
409	230T	6.9	3.37	0.9	88.83	1.4	34.0
410	A. A	-	-	-	-	1.1	36.0
411	19a	-	-	-	-	1.4	33.5
412	37c	10.9	3.43	0.95	84.72	0.85	34.3
413	11L	-	-	-	-	1.6	33.0
414	130L	7.48	3.49	0.79	88.24	1.26	34.3
415	146W. T	-	-	-	-	0.7	34.8
416	222	-	-	-	-	1.35	31.2
417	H. R	-	-	-	-	.85	34.8
418	s. o. p	-	-	-	-	0.1	37.2
419	a. c. g. Dairy butter	-	-	-	-	26.5	

MISCELLANEOUS ANALYSES.

L. H. MERRILL.

In addition to the analytical work attending the fertilizer inspection, in which the writer has had part, he has had charge, during the past year, of the box experiments carried on in the forcing-house. The results of this work will be published later. The following analyses of fodders, Paris green and miscellaneous samples may be given here.

DATA RELATING TO DIGESTION EXPERIMENTS.—COMPOSITION OF FOODS.

	Water.	Ash.	Protein.	Fibre.	Nitrogen free extract.	Fat.
CCLXIII Hay, fed alone	5.90	4.87	7.00	30.85	48.61	2.87
CCLXIV Hay fed with Southern corn silage	6.15	5.04	7.06	30.31	48.39	3.05
CCLXV Hay fed with field corn silage	5.62	4.91	7.18	30.37	48.97	2.95
CCLXVI Southern corn silage fed alone*	5.68	7.97	10.56	29.08	43.51	3.25
CCLXVII Southern corn silage fed with hay*	6.15	7.74	10.44	28.67	42.65	4.35
CCLXVIII Field corn silage fed with hay*	7.45	5.42	11.12	20.45	50.98	4.58
CCLXXVIII Corn meal, Maine grown	20.09	1.33	10.00	1.57	65.19	1.82
CCLXXIX Cotton seed meal	11.73	7.41	45.81	5.62	17.06	12.37
CCLXXX Cob meal	19.81	1.49	10.00	7.82	59.88	1.00
CCLXXXI Field corn silage fed alone*	5.91	5.17	11.25	20.56	51.50	5.61

* Air-dry.

COMPOSITION OF THE FECES.*

Sheep Experiments.	Water.	Ash.	Protein.	Fiber.	Nitrogen free extract.	Fat.
CCLI Sheep 1, hay alone	5.53	7.51	7.94	34.78	41.31	2.93
CCLII Sheep 3, hay alone	5.54	7.41	8.50	33.38	41.63	3.54
CCLIII Sheep 4, hay alone	5.63	7.30	8.45	34.66	41.00	2.96
CCLIV Sheep 1, Southern corn silage	5.47	10.78	12.00	25.87	42.93	2.95
CCLV Sheep 3, Southern corn silage	5.17	11.20	11.81	26.13	42.72	2.97
CCLVI Sheep 4, Southern corn silage	5.06	11.15	11.19	26.17	43.73	2.70
CCLVII Sheep 1, Southern corn silage and hay	5.57	9.21	9.06	30.54	42.40	3.14
CCLVIII Sheep 3, Southern corn silage and hay	5.45	9.13	10.00	30.36	41.94	3.12
CCLIX Sheep 4, Southern corn silage and hay	5.04	9.00	9.62	31.75	41.65	2.94
CCLX Sheep 1, field corn silage and hay	4.78	9.13	10.75	29.87	42.70	9.77
CCLXI Sheep 3, field corn silage and hay	4.60	9.85	11.69	28.15	42.24	3.47
CCLXII Sheep 4, field corn silage and hay	4.02	9.40	11.19	30.00	42.33	3.06
CCLXXXII Sheep 1, field corn silage	4.50	12.44	14.44	18.39	47.56	2.62
CCLXXXIII Sheep 3, field corn silage	3.87	13.33	16.81	18.26	44.34	3.39
CCLXXXIV Sheep 4, field corn silage	3.66	13.61	15.00	19.24	45.42	3.07

* Air-dry.

PARIS GREEN.

Five samples were examined.

CCLXXXVI. Strictly pure Paris green. Boston Color Co. Sent by John Watson, Houlton.

CCLXXXVII. English pure Paris green. Liverpool Paint and Color Co. Sent by John Watson.

CCLXXXVIII. Strictly pure Paris green. Canada Paint Co. Sent by John Watson.

CCLXXXIX. Strictly pure Paris green. James I. Blanchard. Purchased from Merrill and Nichols, Orono.

CCCII. A sample forwarded by Fred S. Wiggin, Maysville Center. The manufacturer's name was not given.

As the efficiency of Paris green is dependent upon the amount of arsenious acid present, no other ingredient was determined.

CCLXXXVI,	arsenious	acid,	54.61	per cent.
CCLXXXVII,	"	"	55.39	" "
CCLXXXVIII,	"	"	54.70	" "
CCLXXXIX,	"	"	55.84	" "
CCCII,	"	"	40.86	" "

The amount of arsenious acid in a good Paris green is somewhat variable ranging from 54 to 61 per cent. The three samples sent by Mr. Watson were reported as failing to give satisfactory results, and adulteration was suspected. As will be seen, however, they all proved good.

SUNDRY ANALYSES.

CCL. Wood Ashes. From B. W. McKeen. Potash 7.82 per cent.

CCCXCIV. Marl. From C. Fred Ames, Fort Fairfield. Carbonate of lime, 83.22 per cent.

CCCXCV. Soil from J. D. Millikin, Scarboro. Water, 40.65. Nitrogen, 1.45. Potash, 0.14. Phosphoric acid, 0.17 per cent.

CCCXCVII and CCCXCVIII. Rock dust. From Maine Red Granite Co., Red Beach, Me.

CCCXCVII. Potash, 4.31 per cent. Phosphoric acid, 0.41 per cent.

CCCXCVIII. Potash, 3.18 per cent. Phosphoric acid, 0.19 per cent.

FIELD EXPERIMENTS WITH FERTILIZERS.

W. H. JORDAN.

One of the oldest, and evidently one of the most popular, classes of experiments conducted by experiment stations is field experiments in the use of fertilizers. The Maine Station has shared with other stations in this work and is now tilling experimental plots for the eleventh season.

After experience for this length of time, the writer is obliged to confess that the results obtained, although valuable enough to be well worth securing, are not so satisfactory as are those obtained along some other lines by more accurate and severe methods. Field experiments of whatever kind are not subject to exact control. They are widely open to sources of error, and for this reason they are difficult of safe interpretation. The publication of a single season's results is justified only on the ground of a pardonable ambition to show what and how much a station is trying to accomplish, but to draw hard and fast conclusions from one year's results is rarely warranted. After ten years have elapsed, however, the accumulated data possess a significance not possible in the early stages of the work. There are presented here therefore, not only the unpublished data of several years work but also a summary of results secured during nine years.

The problems that have been studied through field experiments with fertilizers are those that are plainly indicated by practical work as the important ones.

(1) The relative utility of different forms of phosphoric acid.

(2) The effect of partial and complete fertilizers.*

(3) The relative effect of different amounts of fertilizer.

(4) The possibility of maintaining fertility by the use of commercial fertilizers alone. (Systems of manuring.)

The matter of profit is not immediately connected with these experiments. Indeed it is not possible to order them with reference to profit, consequently in their discussion the cost of production is not considered

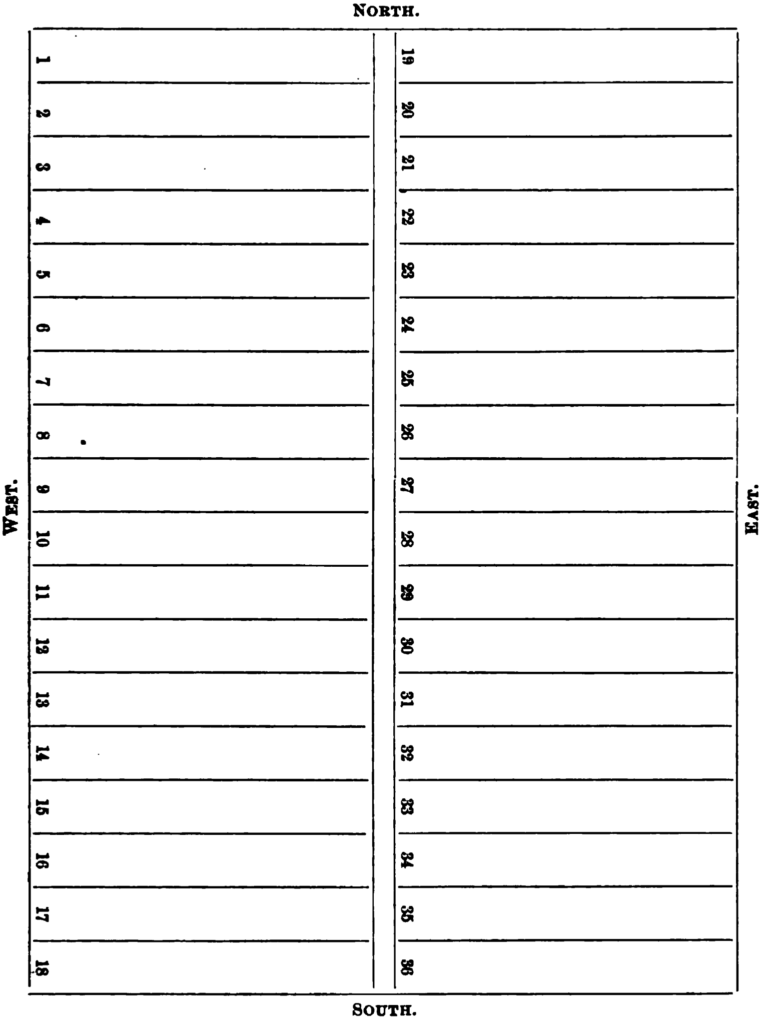
---

*The term complete is used here as meaning a fertilizer that contains nitrogen, phosphoric acid and potash. Such a fertilizer mixed in a particular manner, may or may not be complete in the sense of supplying the needs of a crop under given conditions.

These experiments involve the use of about twelve acres of land, nearly two acres (Field No. 1) of which are divided into thirty-six plots each 8x1 rods, containing one-twentieth of an acre, and ten acres (Field No. 2) divided into four plots, each two and one-half acres in area. The manner of treating the plots has been described in several previous reports of the Station but is restated in this connection for convenience of reference.

The diagram of field No. I is as follows:

DIAGRAM OF EXPERIMENTAL FIELD No. 1.



While these plots appear to lie with their side boundaries in contact, there is really a strip of land eight feet wide separating them. This strip gives an opportunity for a ditch that secures surface drainage, and also prevents the fertilizer applied to any plot from having an influence upon those plots adjoining.

Of these thirty-six plots, six have been cropped without the addition of any fertilizer whatever. The remaining thirty plots have been occupied with ten methods of treatment, three plots being treated in the same manner in each case.

The quantities of fertilizers given in the table below are those applied in a single year.**

Plot 1 " 7 " 13	Received no fertilizer.
Plot 2 " 8 " 14	Dissolved bone black, 400* lbs. per acre. Muriate of potash, 100 lbs. per acre. Sulphate of ammonia,¶ 200 lbs. per acre.
Plot 3 " 9 " 15	Fine ground bone, 360 lbs. per acre. Muriate of potash, 100 lbs. per acre. Sulphate of ammonia,¶ 140 lbs. per acre.
Plot 4 " 10 " 16	Fine ground South Carolina rock, 300 lbs. per acre. Muriate of potash, 100 lbs. per acre. Sulphate of ammonia,¶ 200* lbs. per acre.
Plot 5 " 11 " 17	Muriate of potash, 100 lbs. per acre. Sulphate of ammonia, 200 lbs. per acre.
Plot 6 " 12 " 18	Stable manure, 40,000 lbs. per acre.
Plot 19 " 25 " 31	Received no fertilizer.
Plot 20 " 26 " 32	Dissolved bone black, 400* lbs. per acre.
Plot 21 " 27 " 33	Dissolved bone black, 400* lbs. per acre. Muriate of potash, 100 lbs. per acre.
Plot 22 " 28 " 34	Dissolved bone black, 200† lbs. per acre. Muriate of potash, 50 lbs. per acre. Sulphate of ammonia,¶ 60 lbs. per acre.
Plot 23 " 29 " 35	Dissolved bone black, 300‡ lbs. per acre. Muriate of potash, 100 lbs. per acre. Sulphate of ammonia,¶ 120 lbs. per acre.
Plot 24 " 30 " 36	Dissolved bone black, 400* lbs. per acre. Muriate of potash, 150 lbs. per acre. Sulphate of ammonia,¶ 180 lbs. per acre.

**Dissolved bone black was used as one source of phosphoric acid from 1886 to 1889 inclusive, after which dissolved South Carolina rock was used instead.

* Or dissolved South Carolina rock, 500 lbs.

† Or dissolved South Carolina rock, 250 lbs.

‡ Or dissolved South Carolina rock, 375.

¶ Or nitrate of soda.

The history of these plots is summarized below.

Year.	Crop.	Treatment.
1886,	Oats,	Fertilizers applied.
1887,	Oats,	Fertilizers applied.
1888,	Hay,	No fertilizers.
1889,	Fallowed,	Fertilizers applied.
1890,	Peas,	No fertilizers.
1891,	Oats,	No fertilizers.
1892,	Peas,	No fertilizers.
1893,	Corn,	Fertilizers applied.
1894,	Corn,	Fertilizers applied.

It appears then that in nine years five applications of fertilizer have been made and eight crops produced.

Since 1891 no statement of the crops grown has been published. In order that these results may have a permanent record the yields from these plots in 1892, 1893 and 1894 are given in Table 1, after which the production for the nine years is condensed in a proper form for comparison.

TABLE I.

FERTILIZERS APPLIED PER ACRE AND YIELD PER PLOT, 1892, 1893, 1894.

Plot	Fertilizers as applied in 1886, 1887, 1889, 1893 and 1894. None used in 1888, 1890, 1891 and 1892.	1892. Crop, Peas. Grain.	1892. Crop, Peas. Straw.	1892. Crop, Peas. Total.	1893. Crop, corn, green weight.	1894. Crop, corn, green weight.
Plot 1	No manure.	15.5	22.5	37	80	300
Plot 7		8.5	16.5	25	100	175
Plot 13		12	17	29	70	150
Plot 2	Fertilizer from 400 lbs. dissolved bone black,* 100 lbs. muriate of potash and 200 lbs. sulphate of ammonia,† mixed.	19	9	28	225	605
Plot 8		21	8.5	29.5	350	600
Plot 14		16.7	10.3	27	285	600
Plot 3	Fertilizer from 360 lbs. ground bone, 100 lbs. muriate of potash and 200 lbs. sulphate of ammonia,† mixed.	13.5	9.5	23	305	660
Plot 9		21.7	9.8	31.5	315	500
Plot 15		17	9	26	280	640
Plot 4	Fertilizer from 300 lbs. fine ground South Carolina rock, 100 lbs. muriate of potash and 200 lbs. sulphate of ammonia,† mixed.	14.7	9.3	24	175	480
Plot 10		16.5	6	22.5	330	400
Plot 16		10.3	7.7	18	200	665
Plot 5	Fertilizer from 100 lbs. muriate of potash, 200 lbs. sulphate of ammonia,† mixed.	15	10	25	175	430
Plot 11		23.5	13.5	37	305	550
Plot 17		17	9.5	26.5	225	500
Plot 6	Fertilizer, 40,000 lbs. stable manure.	26.5	9.5	36	480	890
Plot 12		22.5	17.5	40	460	750
Plot 18		55	17	72	650	830
Plot 19	No manure.	24.5	12	36.5	60	300
Plot 25		14.5	10.5	25	125	400
Plot 31		15	12	27	50	190
Plot 20	Fertilizer, consisting of 400 lbs. dissolved bone black alone.*	13.3	5.7	19	90	210
Plot 26		8	4.5	12.5	155	430
Plot 32		12	6.5	18.5	120	350
Plot 21	Fertilizer from 400 lbs. dissolved bone black,* 100 lbs. muriate of potash, mixed.	12.5	5.5	18	270	450
Plot 27		10	5	15	345	520
Plot 33		12.5	9.5	22	270	620
Plot 22	Fertilizer from 200 lbs. dissolved bone black,‡ 50 lbs. muriate of potash and 60 lbs. sulphate of ammonia,† mixed.	15	8	23	175	430
Plot 28		11	6.7	17.7	235	570
Plot 34		13	10	23	180	480
Plot 23	Fertilizer from 300 lbs. dissolved bone black,|| 100 lbs. muriate of potash and 120 lbs. sulphate of ammonia,† mixed.	16.5	6.5	23	265	650
Plot 29		21.7	9.3	31	230	590
Plot 35		17.5	10.5	28	235	620
Plot 24	Fertilizer from 400 lbs. dissolved bone black,* 150 lbs. muriate of potash and 180 lbs. sulphate of ammonia,† mixed.	19.5	7.5	27	305	720
Plot 30		22.7	4.3	27	355	720
Plot 36		20.5	7	27.5	385	720

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* Or 500 lbs. dissolved South Carolina rock.

‡ Or 250 lbs. dissolved South Carolina rock.

|| Or 375 lbs. dissolved South Carolina rock.

† Or same weight nitrate of soda.

In 1893 fifty pounds of corn were selected from each plot, making 150 pounds for each set of three plots. This was stored in the barn for a time and was then weighed, chopped and sampled. The samples were dried in a closet heated by steam, and then after standing in the air of an ordinary room for several weeks were weighed. These weights were taken as those in the air dry condition. In 1894 practically the same course was pursued only the samples were selected for drying as the corn was chopped for the silo in the fresh green state. The moisture in the air-dry samples for 1894 was also determined in order to ascertain the yield of dry matter. (See Table 2.)

TABLE II.

	1893—Air dry material per cent from green corn.	1894.	
		Air dry material per cent from green corn.	Per cent of dry matter in green corn.
Plots 1, 7, 13	23.7	21.4	19.8
Plots 2, 8, 14	24.4	24.3	22.4
Plots 3, 9, 15	22.1	24.0	22.0
Plots 4, 10, 16	22.9	25.2	23.4
Plots 5, 11, 17	22.4	22.0	20.4
Plots 6, 12, 18	27.5	21.2	19.8
Plots 19, 25, 31	24.4	18.8	17.3
Plots 20, 26, 32	23.6	19.0	17.5
Plots 21, 27, 33	25.2	21.1	19.7
Plots 22, 28, 34	23.9	20.1	18.5
Plots 23, 29, 35	19.9	20.3	18.8
Plots 24, 30, 36	27.5	*21.5	*20.0

*Assumed.

By the use of the foregoing data the production of air dry material in the corn for the years 1893 and 1894 is calculated.

The succeeding table (Table 3) shows the yield of air dry material from the crops under consideration since the experiments were begun in 1886.

The quantities stated represent the rate of production of per acre. The data for the years previous to 1892 have been copied, from the reports of these experiments published up to that time.

TABLE III.

SUMMARY OF YIELD PER ACRE OF FIELD NO. 1, FOR EIGHT YEARS.

		No fertilizer. Plots 1, 7, 13.	Complete fertilizer, phosphoric acid from dissolved bone black. Plots 2, 8, 14.	Complete fertilizer, phosphoric acid from ground bone. Plots 3, 9, 15.	Complete fertilizer, phosphoric acid from crude South Carolina rock. Plots 4, 10, 16.	Only nitrogen and potash applied. Plots 5, 11, 17.	Stable manure. Plots 6, 12, 18.
1886, Oats	Grain	1,670	2,486	2,286	2,166	1,936	2,216
	Straw	1,994	3,414	3,134	2,886	2,564	3,050
	Total	3,664	5,900	5,420	5,052	4,500	5,266
1887, Oats	Grain	800	1,160	956	1,064	1,052	1,014
	Straw	1,200	2,240	1,610	2,036	1,648	2,060
	Total	2,000	3,400	2,566	3,100	2,700	3,074
1888, Hay		2,566	2,434	2,800	2,566	2,234	4,010
1889, Fallow							
1890, Peas	Grain	742	902	946	848	762	1,360
	Straw	664	948	976	914	660	1,284
	Total	1,406	1,850	1,922	1,762	1,422	2,644
1891, Oats	Grain	1,166	1,346	1,376	1,160	1,296	1,542
	Straw	726	986	1,090	776	704	1,746
	Total	1,892	2,332	2,466	1,936	2,000	3,288
1892, Peas	Grain	468	368	376	308	440	588
	Straw	748	756	696	552	740	1,388
	Total	1,216	1,124	1,072	860	1,180	1,976
1893, Corn	Green	1,666	5,800	6,000	4,700	4,040	10,660
	Air-dry	395	1,415	1,326	1,076	905	2,931
1894, Corn	Green	3,500	12,040	12,660	10,440	8,540	16,800
	Air-dry	749	2,926	3,088	2,631	1,879	3,562
	Dry matter	688	2,697	2,785	2,443	1,742	3,326
Total yield, 8 crops		13,888	21,881	20,610	18,983	16,820	26,751
Increase of yield over plots without fertilizer			7,331	6,560	4,933	2,770	12,701
Annual increase			916	820	617	346	1,588

TABLE III—CONTINUED.

		No fertilizer. Plots 19, 25, 31.	Phosphoric acid alone. Plots 20, 26, 32.	Phosphoric acid and potash. Plots 21, 27, 33.	Complete fertilizer, 360 lbs. per acre. Plots 22, 28, 34.	Complete fertilizer, 595 lbs. per acre. Plots 23, 29, 35.	Complete fertilizer, 830 lbs. per acre. Plots 24, 30, 36.
1886, Oats	Grain	1,574	1,656	1,630	1,726	2,070	2,040
	Straw	2,394	2,856	3,276	3,006	3,570	3,994
	Total	3,968	4,512	4,906	4,732	5,640	6,034
1887, Oats	Grain	846	870	732	900	858	1,214
	Straw	1,554	1,230	1,902	1,934	2,642	2,620
	Total	2,400	2,100	2,634	2,834	3,500	3,834
1888, Hay		1,634	2,166	2,066	2,166	1,766	2,374
1889, Fallow.							
1890, Peas	Grain	764	852	958	894	822	954
	Straw	854	922	1,020	844	872	824
	Total	1,618	1,774	1,978	1,738	1,694	1,778
1891, Oats	Grain	1,192	1,256	1,264	1,202	1,278	1,278
	Straw	876	1,410	1,404	1,294	1,422	1,388
	Total	2,068	2,666	2,668	2,496	2,700	2,666
1892, Peas	Grain	460	224	268	328	348	248
	Straw	720	444	468	520	744	836
	Total	1,180	668	736	848	1,092	1,084
1893, Corn	Green	1,500	2,440	5,900	3,940	4,860	7,440
	Air-dry	366	576	1,486	942	967	2,046
1894, Corn	Green	5,260	6,740	12,000	9,860	12,800	15,940
	Air-dry	978	1,280	2,532	1,982	2,598	3,427
	Dry matter	910	1,179	2,364	1,824	2,406	3,188
Total yield, 8 crops		14,212	15,742	19.006	17,738	19,957	23,243
Increase of yield over plots not fertilized			1,690	4,956	3,688	5,907	9,193
Annual increase			211	619	461	738	1,149

The previous tables present a statement of the production of the entire system of plots, without any special classification of the results with reference to the problems involved. Such a classification is necessary in order to discover more clearly the nature of the testimony offered.

THE RELATIVE UTILITY OF DIFFERENT FORMS OF PHOSPHORIC ACID.

Ever since commercial fertilizers have come into general use more or less discussion has been carried on as to the value of insoluble phosphates as a source of phosphoric acid. This discussion has been chiefly caused by the fact that phosphoric acid has cost much less in the crude condition than after treatment with sulphuric acid. It has been generally conceded that the less soluble and cheaper form of plant food is more likely to prove useful in grass and grain growing than with hoed crops, because in the first case permanency of effect is desired and in the latter, immediate availability is the essential thing.

It is true, however, that in later years we have come to more fully appreciate the ability of plants to make their own solutions of food from the minerals of the soil that are highly inert so far as it is a question of solution in water, and we have known for a long time that the water-soluble phosphates of fertilizers revert very rapidly after contact with the soil to these forms that are easily dissolved only by acids, the chief advantage secured by the manufacture of a superphosphate being that its compounds become distributed in the soil in a more finely divided condition than is possible in any other way and so become more fully accessible to root action. The results of these experiments are in accord with the tendency to accord to insoluble phosphates a larger place in practice. (See Table 4.)

TABLE IV.

	Yield per acre of air-dry crops.		
	Total yield in 8 years.	Total excess of yield over plots not fertilized.	Annual excess of yield over plots not fertilized
	lbs.	lbs.	lbs.
Plots receiving no fertilizer (average of 6)	14,050		
Complete fertilizer, phosphoric acid largely dissolved.	21,381	7,331	916
Complete fertilizer, phosphoric acid from ground bone,	20,610	6,560	820
Complete fertilizer, phosphoric acid from crude ground South Carolina rock	18,983	4,933	617
Fertilizer containing nitrogen and potash, but no phosphoric acid	16,820	2,770	346

We have in the above figures conclusive evidence that the phosphoric acid of the bone and ground South Carolina rock was quite freely appropriated, though not to the same extent as from the dissolved phosphate.

The quantities stated are the total crop harvested in eight years. Another arrangement of figures is necessary to show whether the increased yield occurred with all crops alike is only with certain ones. With the exception of the hay, only those crops are given in Table 5 which were the first ones grown after the application of the fertilizers.

TABLE V.

	Excess of yield over plots not fertilized.					
	Oats. 1886.	Oats. 1887.	Hay. 1888.	Peas. 1890.*	Corn. 1893.	Corn. 1894.†
Complete fertilizer, phosphoric acid dissolved	2,236	1,400	—132	444	1,020	2,004
Complete fertilizer, phosphoric acid from ground bone	1,756	566	234	516	931	2,092
Complete fertilizer, phosphoric acid from crude South Carolina rock	1,388	1,100	-	356	681	1,750
Nitrogen and potash without phosphoric acid	836	700	—332	16	510	1,049

* Fertilizers applied in 1889, and land summer fallowed.

† Yield of dry matter.

In the light of the facts here presented it is necessary to admit that the water-insoluble forms of phosphoric acid have been utilized by at least three species of farm crops.

THE EFFECT OF PARTIAL AND COMPLETE FERTILIZERS.

It has for some time been well enough established that under average conditions a complete fertilizer, viz: one containing compounds of nitrogen, phosphoric acid and potash causes a larger increase of crop than a fertilizer containing only one or two of these ingredients. It is equally plain that one ingredient often has a preponderating influence, and more often two of these ingredients combined are nearly as useful as the three. Unfortunately the results of experiments in a particular locality do not with any certainty apply to any other locality as indicating the special needs of the soil, and these experiments at the College were not undertaken with the idea of establishing formulæ of general use in the State.

It seemed desirable, however, to ascertain what would be the outcome of fertilizing continuously with partial fertilizers in a soil that has seemed to especially need the mineral ingredients. This can be seen in Table VI.

TABLE VI.

	Yield per acre of air-dry crops.		
	Total yield in 8 years.	Total increase of yield over plots not fertilized.	Annual increase of yield over plots not fertilized.
Plots receiving no fertilizer (average of 6)	14,050		
Fertilizer supplying only phosphoric acid	15,742	1,690	211
Fertilizer supplying phosphoric acid and potash	19,006	4,956	619
Fertilizer supplying nitrogen and potash	16,820	2,770	346
Fertilizer supplying nitrogen, phosphoric acid and potash	21,381	7,331	916

While there is certainly an increase of crop from every combination of ingredients used, there is no doubt of the superior influence of the mixture of the three.

THE RELATIVE EFFECT OF DIFFERENT AMOUNTS OF FERTILIZER.

One of the important considerations pertaining to the use of commercial fertilizers is the quantity to be applied. In these experiments the amount of complete fertilizer applied per acre on one set of three plots has been at the rate of 360 pounds per acre, on another set 595 pounds and on a third set 830 pounds. The results show that the increase of production has been almost directly proportional to the amount of fertilizer used.

TABLE VII.

	Total yield in 8 years.	Total increase of yield over plots not fertilized.	Increase of yield for each pound of fertilizer applied.
Plots receiving no fertilizer (average of 6)	14,050		
Plots receiving 360 lbs. fertilizer per acre	17,738	3,688	2.05
Plots receiving 595 lbs. fertilizer per acre	19,957	5,907	1.95
Plots receiving 830 lbs. fertilizer per acre	23,243	9,193	2.25

THE COMPARATIVE RESULTS WITH COMMERCIAL FERTILIZERS AND WITH STABLE MANURE.

The figures contained in the succeeding table should be suggestive to two classes of farmers: (1) Those who are skeptical about the real value of commercial manures for feeding plants, and (2) those who carelessly allow a waste of plant food from the stable which is no less valuable than that which is purchased.

TABLE VIII.

	Yield per acre of air-dry fodder.		
	Total yield in 8 years.	Total excess of yield over plots not fertilized.	Annual excess of yield over plots not fertilized.
Plots receiving no fertilizer	14,050		
Plots receiving 360 lbs. fertilizer per acre	17,738	3,688	461
Plots receiving 595 lbs. fertilizer per acre	19,957	5,907	738
Plots receiving 800 lbs. fertilizer per acre	21,381	7,331	916
Plots receiving 830 lbs. fertilizer per acre	23,243	9,193	1,149
Plots receiving 40,000 lbs. stable manure per acre	26,751	12,701	1,588

The fact of greater production from the stable manure than from the commercial fertilizers is what would reasonably be expected when we consider the larger amount of plant food contained in the former. If the stable manure was of average composition, and it was at least as rich as that, the quantities of plant food supplied would not be far from the following:

TABLE IX.

	Applied per acre.		
	Nitrogen—lbs.	Phosphoric acid—lbs.	Potash—lbs.
In 46,000 lbs. stable manure	196	128	176
In the largest amount commercial fertilizers	30 to 40	75	75

It seems quite evident that a larger percentage of the materials furnished by the commercial fertilizers has been appropriated by the growing crops than was the case with the stable manure. This may due, however, to the smaller supply from commercial sources.

SYSTEMS OF MANURING.

In 1888 this Station began a field experiment upon a somewhat large scale, which was designed for the purpose of securing information on two points of great practical interest:

1st. The possibility of maintaining soil fertility by the use of commercial fertilizers alone.

2nd. The comparative value for general farming of crude and dissolved phosphates.

This experiment was under the immediate direction of Professor Walter Balentine until his death in 1894 when it passed to the care of the writer. The data from four years work are given in the Station reports for 1890 and 1891 but for various reasons no report has been made of the results reached since the season of 1891, at which time the plot were sown to oats and seeded with timothy and clover. In reporting the additional data secured, it appears desirable to restate the plan and conditions of the experiment and summarize the seven years results.

The experimental field consists of ten acres, divided into four plots of two and one-half acres each. The treatment decided upon for each of these plots was as follows:

EXPERIMENTAL FIELD No. 2.

North.

No. 1. 20 loads (6⅔ cords) Stable Manure per acre.	2½ Acres.
No. 2. 1,000 lbs. South Carolina Rock, 66 lbs. nitrate of soda, 16 lbs. sulphate of ammonia, 100 lbs. muriate of potash per acre.	2½ Acres.
No. 3. 500 lbs. Acid South Carolina Rock, 66 lbs. nitrate of soda, 16 lbs. sulphate of ammonia, 100 lbs. muriate of potash per acre.	2½ Acres.
No. 4. No manure.	2½ Acres.

South.

In 1890 the fertilizers were applied, since which four crops have been grown. In 1891 the plots were sown to oats and seeded to clover, but this was all killed during the succeeding winter, so that the land was again plowed in the spring of 1892 and sown to barley, which was cut and cured for hay. During the summer of 1893 the plots were kept fallow and tilled as an attempt to eradicate certain most pernicious cruciferous weeds. In 1894 the land was again sown to oats, but as the crucifers were not all exterminated and it was desirable that they should not ripen and scatter their seeds, the oats were cut before maturing and used for silage.

Large samples (1,000 pounds from each plot) of the green oats were selected and cured, from which smaller samples of air-dry material were taken in order to determine the percentage of dry matter in the crop as cut.

TABLE X.

YIELD PER ACRE FOR THE YEARS 1888 TO 1894, INCLUSIVE.

	Plot 1. Barn manure.	Plot 2. Phosphoric acid, crude.	Plot 3. Dissolved phosphate.	Plot 4. Nothing.
	lbs.	lbs.	lbs.	lbs.
Hay, average yield 1888 and 1889	2,542	2,416	2,082	2,510
Barley and peas, combined yield, 1890*	2,208	1,712	1,422	1,118
Oats, 1891. Grain	1,536	1,447	1,523	1,304
Straw	2,282	1,534	1,449	1,176
Total	3,818	2,981	2,972	2,480
Barley hay, 1892	3,444	2,324	1,930	1,161
Summer tilled, 1893.				
Oats, 1894. Green crop	9,968	10,264	7,608	6,340
Dry matter	1,894	2,433	1,734	957.3
Yield without fertilizers as calculated from the relative production of 1888–1889	966	919	766	957.3
Gain caused by fertilizers in 1894	928	1,534	968	

*Fertilizers applied this year.

The plots have been treated during the seven years from 1888 to 1894 inclusive as shown by the summary given below:

Year.	Manuring.	Crop produced.
1888,	No fertilizer,	Grass.
1889,	No fertilizer,	Grass.
1890,	Fertilizer applied,	Peas and barley.
1891,	No fertilizer,	Oats, seeded down.
1892,	No fertilizer,	Barley, cut for hay.
1893,	No fertilizer,	Summer fallowed and tilled.
1894,	No fertilizer,	Oats, cut green for silo.

It seems that during seven years the plots have produced six crops, have received one application of the fertilizers and have been summer tilled once. Two years were allowed to elapse before any fertilizer was applied, during which time the grass crop was cut and the hay weighed, in order to ascertain the relative natural productiveness of the plots before receiving special treatment.

The above figures effectually answer the question so often proposed by farmers, "Do commercial fertilizers have influence upon more than the first crop succeeding their application?"

In this instance the fertilizers were applied in 1890 and at the end of the season of 1894 five crops of grain had been removed without any further manuring, but even after the growth of three previous crops the one of 1894 shows in a marked manner the influence of the fertilizers used in 1890. It is too early however, to reach any conclusion as to whether commercial fertilizers can be depended upon as a source of fertility for all time.

This experiment has already furnished a bit of not insignificant testimony on the use of raw ground mineral phosphates, for grain growing at least. Plots two and three were treated exactly alike excepting that the phosphoric acid applied to plot three was chiefly in the soluble and reverted form, while on plot two it was used in much larger quantities almost wholly in the insoluble form. In other words, an acid or soluble phosphate was used on plot three and a crude ground phosphate on plot two.

TABLE XI.

INGREDIENTS APPLIED IN COMMERCIAL FERTILIZERS ON PLOT TWO AND THREE.

	Plot 2—pounds.	Plot 3—pounds.
Phosphoric acid, mostly dissolved	-	80
Phosphoric acid, undissolved	250	
Potash	50	50
Nitrogen	14	14

With the exception of the oat crop of 1891 the production of plot two has largely exceeded that of plot three. Especially is this true of the 1894 crop after the exhausting effect of three years of cropping. In this year the greater productiveness of plot two is very marked, the excess of yield being 566 pounds of dry matter. This is certainly one instance of the unmistakable persistent influence of a crude phosphate in increasing the growth of a field crop.

In comparing the relative effect of the barn manure and the commercial fertilizers it is clearly seen that for the first three crops the former caused the greater increase of production. If we compare the plant food furnished to each of the several plots, this appears to be a most natural result as much the larger amount was applied to the barn manure plot.

TABLE XII.

PLANT FOOD SUPPLIED TO THE SEVERAL PLOTS.

	Nitrogen—pounds.	Phosphoric acid—pounds.	Potash—pounds.
Plot 1	172	116	176
Plot 2	14	250	50
Plot 3	14	80	50
Plot 4	0	0	0

Only in the case of the phosphoric acid of Plot 2 do the commercial manures exceed or even approach in quantity the plant food furnished by the stable manure. This greater amount of plant food does not fail of its effect, but it is worthy of remark that after three crops have been removed the yield of Plot 1 is inferior to that of Plot 2 and scarcely greater than that of Plot 3. A possible explanation of this is that the soil is especially lacking in available phosphoric acid and therefore the larger amount of this compound applied to Plot 2 resulted in a more persistent increase of crop. These results so far run counter to the prevailing views as to the relative permanence of effect of animal and commercial manures.

But the experiment is still in progress and definite conclusions should be withheld for some years.

The following, however, is a brief summary of the more important facts to date, as bearing upon the experiment on Field 2:

(1) The commercial fertilizers have caused a marked increase of crop for at least four years after their application.

(2) The fourth crop was larger from the crude phosphate than from the dissolved.

(4) The first three crops were larger from the yard manure than from the commercial manures but the fourth crop was larger from the latter.

THE PROFITABLE AMOUNT OF SEED PER ACRE FOR CORN.

W. H. JORDAN.

The opinion has prevailed somewhat in the past, if a practice is any indication of an existing opinion, that the larger the amount of seed used the greater the yield of corn for soiling or fodder purposes.

In many instances not less than a bushel of corn has been sown per acre on the plot that was to furnish fodder corn in late August and during September. The resulting product has always been a large weight of immature, very watery fodder.

Possibly the practice was correct if we assume that the gross weight of a green crop is a correct measure of its value.

We know that this is not the case, but, that the value of any crop is chiefly measured by its yield of dry matter, and we have found out that the largest food product is obtained when the amount of seed approximates, at least, to that planted in ordinary field culture. More or less discussion still exists, however, in regard to the exact quantity of seed that is conducive to the maximum yield. A very common custom is to plant five kernels in a hill with the rows three and one-half feet apart and the hills three feet. This is nearly equivalent to rows the same distance with single kernels drilled in at a distance of seven inches apart.

During the past season an experiment has been carried on by the Station for the purpose of ascertaining the amount of seed most profitable in corn raising.

A plot of one acre was used for this purpose. This plot received five cords of manure and five hundred pounds of commercial fertilizer. It was divided into twelve plots, or four sets of plots with three plots in a set.

On one plot in each set the single kernels were planted six inches apart, on another nine inches, and on the third twelve inches. This gave four plots or one-third of an acre planted by each method. The corn was allowed to stand until the kernels glazed and was then cut, weighed and sampled.

Below can be seen the gross yield of crop per acre, the percentage and the total yield of dry matter.

TABLE XIII.

	Yield of green crop per acre.	Per cent of dry matter in green crop.	Yield of dry matter per acre.
Kernels 6 inches apart or 6 in three feet	21,315	21.1	4,497
Kernels 9 inches apart or 4 in three feet	22,530	20.9	4,708
Kernels 12 inches apart or 3 in three feet	20,190	20.5	4,139

In this instance at least the medium quantity of seed, viz: Four kernels in each three feet, produced the largest yield of both green crop and dry matter. Several similar trials will be made to determine whether this will uniformly occur.

It appears that the corn from the different quantities of seed was of practically uniform composition.

TABLE XIV.

	Water.	Ash.	Protein.	Fiber.	Nitrogen free-extract.	Fats.
Planted with kernels 6 inches apart	78.90	1.09	1.87	4.30	13.07	.76
Planted with kernels 9 inches apart	79.10	1.35	2.02	3.73	12.97	.83
Planted with kernels 12 inches apart	79.50	1.01	1.85	4.40	12.52	.73

DIGESTION EXPERIMENTS.

THE INFLUENCE OF FOOD COMBINATIONS UPON DIGESTIBILITY.

W. H. Jordan.

A large amount of time has been expended in determining the digestibility of our various cattle foods, and the figures obtained are known as coefficients of digestibility. These coefficients are arranged in tables convenient for reference, and are much used in a practical way for the calculation of rations. In practice it is assumed that when the several materials in the ration are multiplied by their respective percentages of digestibility, the sum of the quantities thus obtained will represent very nearly the total digestible material fed; in other words, it is assumed that no matter how foods are combined, each food continues to have its peculiar rate of digestibility, which is not changed to any important extent by the influence of the foods which accompany it.

The correctness of the position is somewhat questioned by those familiar with related facts, their doubt being based not so much upon theoretical reasons as upon the apparent outcome of certain digestion experiments.

The digestibility of a food in a particular instance must be determined by two factors:

(1) What has been termed the "inherent resistance" of the food to the solvent action of the digestible liquids.

(2) The supply in abundance of these digestive fluids.

The writer has always inclined to the view that the first factor is so largely the controlling one that unless the animal is under abnormal conditions it almost wholly determines the amount of the food that shall pass into solution. To illustrate, egg albumen is wholly peptonized by the gastric juice, or starch is wholly inverted to glucose under the action of the pancreatic juice, and these results will always obtain when these two juices are secreted in proper abundance, not being influenced by the relative amounts present of other compounds that are to be digested. There is a possibility that a food may be so distasteful to the animal that the nerve stimulus necessary for the proper secretion of the digestive fluids may be wanting, and in such a case the addition to the ration of anything that would render it more palatable would promote digestibility, but with healthy animals judiciously fed on the ordinary food mixtures, we have no reason to suspect either unpalatableness or an insufficient supply of the digestive juices.

One difficulty in obtaining conclusive testimony on the point under consideration lies in the limitations of digestion experiments, which with ruminants, at least, do not allow the determination of the digestibility of all foods as fed singly.

The co-efficients of digestibility of grains with ruminants have been reached by assuming coarse fodders to have the same digestibility when fed with them as when fed alone. We do not know how much of the grains would be digested when not accompanied by any other food, nor do we know if hay maintains the same digestibility when grains are combined with it. The way by which we can get at the most reliable figures is to experiment with foods that it is practicable to feed both singly and combined.

The digestion experiments at this Station in 1894 have been directed toward gaining information on the points under consideration.

The experimental foods have been Timothy hay and silage. If combination does affect digestibility, it would be likely to occur when two such foods as these are mixed,—the one coarse, dry, quite indigestible and not highly palatable, and the other succulent, much more digestible and very much relished by the animals.

The experiments were conducted with the foods alone and combined, using Timothy hay, silage from the large immature Southern corn and silage from mature Flint corn. The following is a summary of the results:

	Coefficients of digestibility.						
	Dry matter.	Ash.	Organic substance.	Protein.	Fiber.	Nitrogen free-extract.	Fat.
Timothy hay, 600 grs. daily, Sheep 1	54.4	28.8	55.7	48.2	48.7	61.3	57.2
Sheep 2	52.7	28.2	54	42.7	48.9	59.6	41.8
Sheep 3	54.1	31.3	55.3	44.7	48.5	61.2	52.7
Average	53.7	29.4	55	45.2	48.7	60.7	50.6
Silage, Southern corn, 2,000 grs. daily. Sheep 1	64.6	52.3	65.7	59.8	68.5	65.1	67.8
Silage, Southern corn, *2,500 grs. daily. Sheep 2	64.5	50	65.8	60.4	68.2	65.3	67.6
Silage, Southern corn, 2,500 grs. daily. Sheep 3	61.8	46.5	63.1	59.7	65.8	61.8	68.4
Average	63.6	49.6	64.8	59.9	67.5	64.1	67.9
Silage, Maine Flint corn, 2,000 grs. daily. Sheep 1	75.1	41	77.2	68.5	78.1	77.4	88.5
Sheep 2	76	39.4	78.2	64.9	79.2	79.8	85.8
Sheep 3	76.2	39	78.4	68.9	78.2	79.5	87.2
Average	75.7	39.8	77.9	67.4	78.5	78.9	87.1
Combination Southern corn silage and hay. Sheep 1	55.1	30.6	56.8	50.9	54.2	59.3	59
Sheep 2	58.9	38.4	60.3	52	56	62.9	64.4
Sheep 3	57	37.4	58.4	51.4	53.9	61.7	65
Average	57	35.6	58.5	51.4	54.7	61.3	62.8
Combination field corn silage and hay. Sheep 1	73.6	49	74.8	68.6	70.3	77.8	80.4
Sheep 2	66.4	-	68.1	56.7	64.4	72.1	68.7
Sheep 3	67.1	-	68.6	59.6	63.1	72.7	73.2
Average sheep 2 and 3	66.7	-	68.3	58.1	63.7	72.4	70.9

* For analyses of materials see report of L. H. Merrill.

It will be observed that the digestibility of both the hay and the silages was determined with these foods when eaten alone.

- Having these figures it is possible to calculate the digestibility of a known mixture of hay and silage, assuming that the one has no influence on the other. But this is the point in question and in Tables XV and XVI we have a comparison of the theoretical digestibility with what actually occurred.

TABLE XV.

COMBINATION OF HAY AND SOUTHERN CORN SILAGE.

SHEEP 1.	Dry matter.	Ash.	Organic matter.	Protein.	Fiber.	Nitrogen free-extract.	Fats.
Dry matter eaten	2,005	127.4	1,877.4	175.6	635	992.1	74.7
Dry matter actually digested	1,106	39	1,066.8	89.4	344.3	588.3	44.9
Amount digested as calculated from results with foods fed singly	1,161	-	1,099.1	93.5	350.9	620.1	46.1
Per cent actually digested	55.1	30.6	56.8	50.9	54.2	59.3	59
Per cent digested as per calculation	57.9	-	58.5	53.2	55.2	62.5	61.7
SHEEP 2.							
Dry matter eaten	2,177.5	141.6	2,035.7	194.8	687.6	1,070.6	82.6
Dry matter actually digested	1,282.4	55.2	1,227	100.2	400.3	673.3	53.2
Amount digested as calculated from results with foods fed singly	1,219.4	-	1,192.8	100	387	680.5	44.8
Per cent actually digested	58.9	-	60.3	52	58.2	62.9	64.4
Per cent digested as per calculation	57.4	-	58.6	52	56.4	61.7	54.2
SHEEP 3.							
Dry matter eaten—same as Sheep 2							
Dry matter actually digested	1,241.7	53	1,188.5	100	374.8	659.9	53.7
Amount digested as calculated from results with foods fed singly	1,244.4	-	1,187.5	101.5	379	657.6	49.8
Per cent actually digested	57	-	58.4	51.4	53.9	61.7	65
Per cent digested as per calculation	57.1	-	58.3	52.1	55.1	61.4	60.3
Average per cent actually digested	57	-	58.5	51.4	55.4	61.3	62.8
Average per cent digested as per calculation	57.4	-	58.5	52.4	55.5	61.9	56.7

TABLE XVI.

COMBINATION OF HAY AND FIELD CORN SILAGE.

SHEEP 1.	Dry matter.	Ash.	Organic matter.	Protein.	Fiber.	Nitrogen free-extract.	Fat.
Dry matter eaten.	2,297	115.8	2,171.1	218.1	639.5	1,223.7	89.7
Amount actually digested.........	1,690.5	57	1,623.4	149.6	449.2	952.3	72.1
Amount digested as calculated from results with foods fed singly........................	1,454	-	1,409	129.2	375.5	837.7	66.6
Per cent actually digested*	73.6	49	74.8	68.6	70.3	77.8	80.4
Per cent digested as per calculation	63.3	-	64.9	59.2	58.7	68.5	74.2
SHEEP 2.							
Total fed—same as Sheep 1.							
Amount actually digested.........	1,525.2	36.2	1,479	123.6	411.8	881.9	61.6
Amount digested as calculated from results with foods fed singly..............................	1,440.6	-	1,397 3	119.4	378.8	839.2	59
Per cent actually digested.........	66.4	-	68.1	56.7	64.4	72.1	68.7
Per cent digested as per calculation	62.7	-	64.3	54.8	59.2	68.6	65.8
SHEEP 3.							
Total fed—same as Sheep 1.							
Amount actually digested....	1,540.7	-	1,488.8	130	403.2	890	65.6
Amount digested as calculated from results with foods fed singly....	1,460.6	-	1,415.1	126.2	374.9	848.4	64.1
Per cent actually digested.........	67.1	-	68.6	59.6	63.1	72.7	73.2
Per cent digested as per calculation	63.6	-	65.1	57.9	58.6	69.4	71.5
Average per ct. actually digested†	66.7	-	68.3	58.1	63.7	72.4	70.9
Average per cent digested as per calculation†......................	63.1	-	64.7	56.3	58.9	69	68.6

* These coefficients are evidently too high.

† Average to Sheep 2 and 3.

The outcome of these experiments does not give quite so definite testimony as is desirable. In the case of the hay and southern corn silage combination the calculated and the actual digestibility agree very closely, while with the hay and field corn silage the actual digestibility is about 3.5 per cent greater than the calculated. Although this difference is not large, and might occur within the limitations of error with a single experiment, it seems desirable to secure additional evidence before formulating conclusions.

APPENDIX TO DIGESTION EXPERIMENTS.

TABLE XVII.

DIGESTIBILITY OF MIXED HAY.

SHEEP 1.	Dry substance.	Ash.	Organic matter.	Protein.	Fiber.	Nitrogen free-extract.	Fat.
Amount fed in 5 days, 3,000 grs	2,694.1	139.3	2,554.8	200.2	882.3	1,390.2	82.1
Amount excreted in 5 days	1,230	97.8	1,132.2	103.8	452.8	537.9	38.1
Amount digested in 5 days	1,464.1	41.5	1,422.6	96.4	429.5	852.3	44.0
Per cent digested	54.4	28.8	55.7	48.2	48.7	61.3	57.3
SHEEP 2.							
Amount fed in 5 days, 3,000 grs	2,694.1	139.3	2,554.8	200.2	882.3	1,390.2	82.1
Amount excreted in 5 days	1,275.2	100	1,175.2	114.7	450.6	562	47.8
Amount digested	1,418.9	39.3	1,379.6	85.5	431.7	828.2	34.3
Per cent digested	52.7	28.2	54	42.7	48.9	59.6	41.8
SHEEP 3.							
Amount fed in 5 days, 3,000 grs	2,694.1	139.3	2,554.8	200.2	882.3	1,390.2	82.1
Amount excreted in 5 days	1,238.5	95.7	1,142.8	110.8	454.4	538.8	38.8
Amount digested	1,455.6	43.6	1,412.0	89.4	427.9	851.4	43.3
Per cent digested	54.1	31.3	55.3	44.7	48.5	61.2	52.7
Average per cent digested	53.7	29.4	55	45.2	48.7	60.7	50.6

TABLE XVIII.

DIGESTIBILITY OF SOUTHERN CORN SILAGE.

SHEEP 1.	Dry matter.	Ash.	Organic substance.	Protein.	Fiber.	Nitrogen free-extract.	Fat.
Amount fed in 5 days 10,000 grs....	1,360	114.9	1,245.1	152.2	418.9	627.2	46.8
Amount excreted in 5 days	482.1	55	427.1	61.2	131.9	218.9	15
Amount digested	877.9	59.9	818	91	287	408.3	31.8
Per cent digested	64.6	52.3	65.7	59.8	68.5	65.1	67.8
SHEEP 2.							
Amount fed in 5 days 12,500 grs ...	1,700	142.6	1,556.3	190.2	523.6	784	58.5
Amount excreted in 5 days	604.5	71.4	533.1	75.3	166.6	272.3	18.9
Amount digested.....	1,095.5	71.2	1,023.2	114.9	357	511.7	39.6
Per cent digested..................	64.5	50	65.8	60.4	68.2	65.3	67.6
SHEEP 3.							
Amount fed in 5 days	1,700	142.6	1,556.3	190.2	523.6	784	58.5
Amount excreted in 5 days........	650.3	76.4	574	76.6	179.3	299.5	18.5
Amount digested	1,049.7	66.2	982.3	113.6	344.3	484.5	40
Per cent digested.........	61.8	46.5	63.1	59.7	65.8	61.8	68.4
Average per cent digested	63.6	49.6	64.8	59.9	67.5	64.1	67.9

TABLE XIX.

DIGESTIBILITY OF MAINE FIELD CORN SILAGE.

SHEEP 1.	Dry matter.	Ash.	Organic substance.	Protein.	Fiber.	Nitrogen free-extract.	Fat.
Amount fed in 5 days, 10,000 grs....	2,036	111.8	1,924.2	243.3	444.9	1,114.7	121.3
Amount excreted in 5 days........	506.8	66.1	440.8	76.7	97.6	252.5	13.9
Amount digested....................	1,530.2	45.7	1,483.4	166.6	347.3	864.2	108.4
Per cent digested..........	75.1	41	77.2	68.5	78.1	77.4	88.5
SHEEP 2.							
Amount fed in 5 days, 10,000 grs....	2,036	111.8	1,924.2	243.3	444.9	1,114.7	121.3
Amount excreted in 5 days........	488.1	67.7	420.5	85.4	92.7	225.2	17.2
Amount digested..	1,547.9	44.1	1,503.7	157.9	352.2	889.5	114.1
Per cent digested..................	76	39.4	78.2	64.9	79.2	79.8	85.8
SHEEP 3.							
Amount fed in 5 days, 10,000 grs....	2,036	111.8	1,924.2	243.3	444.9	1,114.7	121.3
Amount excreted in 5 days........	485.9	68.6	417.3	75.7	97	229.1	15.5
Amount digested....................	1,550.1	43.2	1,506.9	167.6	347.9	885.6	105.8
Per cent digested...........	76.2	39	78.4	68.9	78.2	79.5	87.2
	75.7	39.8	77.9	67.4	78.5	78.9	87.1

TABLE XX.

DIGESTIBILITY OF HAY AND SOUTHERN CORN SILAGE.

SHEEP 1.	Dry matter.	Ash.	Organic substance.	Protein.	Fiber.	Nitrogen free-extract.	Fat.
Hay fed in 5 days, 1,500 grs	1,314	70.5	1,243.4	98.8	424.3	677.6	42.7
Silage fed in 5 days, 8,000 grs	691	56.9	634.0	76.8	210.7	314.5	32
Total fed	2,005	127.4	1,877.4	175.6	635.0	992.1	74.7
Excreted in 5 days	899	88.4	810.6	86.2	290.7	403.8	29.8
Amount digested	1,106	39.0	1,066.8	89.4	344.3	588.3	44.9
Per cent digested	55.1	80.6	56.8	50.9	54.2	59.3	59
SHEEP 2.							
Hay fed in 5 days, 1,500 grs	1,314	70.5	1,243.4	98.8	424.3	677.6	42.7
Silage fed in 5 days, 6,250 grs	863.5	71.1	792.3	96	263.3	393	39.9
Total fed	2,177.5	141.6	2,035.7	194.8	687.6	1,070.6	82.6
Excreted in 5 days	895.1	86.4	808.7	94.6	287.3	397.3	29.4
Amount digested	1,282.4	55.2	1,227.0	100.2	400.3	673.3	53.2
Per cent digested	58.9	38.4	60.3	52	56	62.9	64.4
SHEEP 8.							
Total fed	2,177.5	141.6	2,035.7	194.8	687.6	1,070.6	82.6
Excreted in 5 days	935.8	88.6	847.2	94.8	312.8	410.7	28.9
Amount digested	1,241.7	53.0	1,188.5	100.0	374.8	659.9	53.7
Per cent digested	57	37.4	58.4	51 4	53.9	61.7	65

TABLE XXI.

DIGESTIBILITY OF HAY AND FIELD CORN SILAGE.

SHEEP 1.	Dry matter.	Ash.	Organic substance.	Protein.	Fiber.	Nitrogen free-extract.	Fat.
Hay fed in 5 days, 1,500 grs	1,309.5	68.1	1,241.4	99.5	421.4	679.6	40.8
Silage fed in 5 days, 5,000 grs	987.5	57.7	929.7	118.6	218.1	544.1	48.9
Total fed	2,297	115.8	2,171.1	218.1	639.5	1,223.7	89.7
Amount excreted in 5 days	606.5	58.8	547.7	68.5	190.3	271.4	17.6
Amount digested	1,690.5	57.0	1,623.4	149.6	449.2	952.3	72.1
Per cent digested	73.6	49	74.8	68.6	70.3	77.8	80.4
SHEEP 2.							
Total fed in 5 days	2,297	115.8	2,171.1	218.1	639.5	1,223.7	89.7
Excreted in 5 days	771.8	79.6	692.1	94.5	227.7	341.8	28.1
Amount digested	1,525.2	36.2	1,479	123.6	411.8	881.9	61.6
Per cent digested	66.4	-	68.1	56.7	64.4	72.1	68.7
SHEEP 3.							
Total fed in 5 days	2,297	115.8	2,171.1	218.1	639.5	1,223.7	89.7
Excreted in 5 days	756.3	74	682.3	88.1	236.3	333.7	24.1
Amount digested	1,540.7	41.8	1,488.8	130	403.2	890	65.6
Per cent digested	67.1	-	68.6	59.6	63.1	72.7	73.2

FEEDING EXPERIMENTS.

LARGE OR SMALL HAY RATION.

One of the subjects that have received more or less attention at farmers' institutes in the past is the amount of hay that can be profitably fed to milch cows. It has been claimed on the part of some of our prominent farmers that if hay is the only coarse food that a cow of ordinary size is eating, fifteen pounds is as much as she will consume with profit when combined with a fairly liberal grain ration.

Some have gone so far as to claim that the yield of milk and butter from the fifteen pounds of hay has, in their experience, been as large as from twenty pounds, the grain ration being the same in both cases, and have explained such a result on the ground that with the large hay ration the animal fails to digest her food properly and so wastes it. Others disagree with this practice and profess not to be able to keep their cows up to a generous flow of milk and a thrifty condition with so small an amount of hay, unless they give an increased grain ration.

In the winter and spring of 1894 the Station undertook to test this matter by an experiment. Briefly stated, the plan of the experiment was this: Three cows were fed during three periods of four weeks each. In the first and last periods the animals received five pounds of hay as a noon feed, but in the second period this was taken away.

A record of the food consumed, the weight of the cows and the yield and composition of the milk was made. The data obtained do not furnish so decisive testimony either way as could be desired, although the figures here presented, accompanied by the observations that were made concerning the general appearance and condition of the animal, give to the experimenter a good basis for an opinion.

The daily rations for the several periods were as follows:*

Tables XXII and XXIII which appear by mistake, on page 48 should follow Table XXI on page 44.

The cow Agnes received the same ration during the first period only that she ate fifteen pounds hay throughout.

Second Period **28 days.** **Cows 1 and 2.**	**First half**	8 pounds hay. 25 pounds silage. 2 pounds cottonseed meal. 5 pounds corn meal.
	Second half	8 pounds hay. 25 pounds silage. 2 pounds cottonseed meal. 5 pounds corn and cob meal.

The cow Agnes received the same ration during the second period only that she ate ten pounds hay throughout.

Third Period **28 days.**	All cows received in this period the same rations as during the first.

The corn meal and corn and cob meal were from the same lot o Maine grown corn.

A sample of the milk of each milking was taken during the las five days of each half period, and the following is the compositio for each five days' test.

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* For composition of foods see report of L. H. Merrill.

COMPOSITION OF MILK.

PERIOD 1.

	Cow 1.		Cow 2.		Agnes.	
January 30, morning	11.87	3.25	13.08	4.10	13.48	4.30
night	13.29	4.50	13.23	4.45	13.61	4.85
January 31, morning	12.75	3.55	12.79	3.85	13.95	4.70
night	12.53	3.95	12.87	4.15	13.56	4.45
February 1, morning	12.14	3.25	12.49	3.85	13.82	4.55
night	12.86	4.15	13.57	4.80	13.60	4.80
February 2, morning	12.20	3.40	12.42	3.95	13.79	4.70
night	12.83	3.95	13.39	4.25	13.43	4.30
February 3, morning	11.88	3.10	12.60	3.90	13.75	4.35
night	12.61	3.85	13.21	4.15	13.69	4.40
	12.45	3.69	12.86	4.14	14.19	4.54
February 13, morning	12.08	3.50	12.95	3.90	13.87	4.70
night	12.69	3.80	13.36	4.05	13.72	4.30
February 14, morning	12.35	3.15	13.37	4.00	14.07	4.35
night	13.39	4.30	13.40	4.00	14.69	5.10
February 15, morning	12.28	3.30	13.12	4.15	14.13	4.75
night	12.25	3.75	12.98	4.15	13.02	4.00
February 16, morning	11.94	3.10	12.84	3.85	13.80	4.55
night	12.50	3.85	12.99	4.05	13.63	4.45
February 17, morning	11.91	3.10	12.93	3.90	14.44	5.00
night	12.44	3.95	12.97	4.00	13.39	4.40
	12.38	3.57	13.13	4.00	13.88	4.56
PERIOD 2.						
February 27, morning	12.01	3.50	12.75	3.85	13.10	4.05
night	12.78	4.00	13.36	4.35	13.23	4.50
February 28, morning	12.27	3.35	13.03	3.75	13.70	4.25
night	12.67	3.95	12.67	4.10	13.99	5.15
March 1, morning	12.58	3.75	12.81	4.00	14.12	5.10
night	12.80	4.15	13.26	4.35	13.49	4.65
March 2, morning	12.27	3.40	12.71	3.70	13.91	4.80
night	12.98	4.45	14.17	4.85	13.49	4.55
March 3, morning	12.18	3.40	13.54	4.15	13.80	4.70
night	12.78	4.20	13.01	4.35	13.65	4.55
	12.58	3.81	13.13	4.14	13.65	4.63

COMPOSITION OF MILK—CONCLUDED.

PERIOD 2—Concluded.

	Cow 1.		Cow 2.		Agnes.	
March 13, morning	11.39	3.10	12.87	3.95	13.62	4.95
night	12.22	3.90	13.28	4.50	13.43	4.65
March 14, morning	11.93	3.25	12.52	3.55	13.38	4.30
night	12.50	4.30	12.69	4.55	14.31	5.45
March 15, morning	12.32	3.50	13.09	4.00	13.96	4.75
night	13.39	4.65	13.07	4.25	13.39	4.65
March 16, morning	11.57	3.10	12.90	3.80	13.48	4.30
night	12.52	4.05	13.24	4.30	13.99	4.60
March 17, morning	12.09	3.25	12.76	3.60	14.30	4.65
night	12.69	4.05	12.82	4.15	13.10	4.45
	12.26	3.71	12.92	4.06	13.70	4.67
PERIOD 3.						
March 27, morning	12.11	3.20	13.00	4.05	14.29	4.90
night	13.30	4.60	13.12	4.40	13.88	5.00
March 28, morning	12.64	3.60	12.85	3.80	14.64	5.25
night	12.61	4.30	13.35	4.30	14.39	4.80
March 29, morning	12.11	3.05	13.20	4.00	14.73	5.15
night	13.75	4.70	13.61	4.50	13.99	4.70
March 30, morning	12.50	3.65	12.93	3.90	14.28	4.85
night	13.20	4.80	13.13	4.25	13.92	5.10
March 31, morning	11.75	3.20	13.18	4.10	14.20	5.25
night	14.09	5.25	14.04	4.80	14.05	4.95
	12.81	4.03	13.24	4.21	14.24	4.99
April 10, morning	12.33	3.70	13.33	4.15	14.85	5.80
night	13.59	5.10	13.20	4.20	13.91	4.70
April 11, lost.						
April 12, morning	12.17	3.40	13.19	4.00	14.56	5.45
night	14.12	5.35	13.06	4.55	13.19	4.05
April 13, morning	12.35	3.45	13.05	4.45	13.99	4.65
night	13.79	4.75	13.73	4.40	14.39	5.00
April 14, morning	12.75	3.60	13.33	4.05	15.35	5.85
night	14.48	5.55	14.07	4.65	13.71	4.40
	13.20	4.36	13.37	4.31	14.24	4.99

TABLE XXII.

COMPOSITION OF FOODS AS FED IN DIGESTION EXPERIMENTS.

	Moisture as fed.	In 100 parts water-free substance.				
		Ash.	Protein.	Fiber.	Nitrogen free-extract.	Fats.
CCLXIII Hay—fed alone	12.1	5.17	7.43	32.75	51.60	3.05
CCLXIV Hay—fed with So. Corn Silage	12.6	5.37	7.52	32.29	51.57	3.25
CCLXV Hay—fed with Field Corn Silage	12.7	5.20	7.61	32.18	51.88	3.13
CCLXVI So. Corn Silage—fed alone	86.4	8.44	11.19	30.77	46.16	3.44
CCLXVII So. Corn Silage—fed with hay	86.18	8.24	11.13	30.56	45.44	4.63
CCLVIII Field Corn Silage—fed with hay	80.25	5.87	12.01	22.10	55.07	4.95
CCLXXXI Field Corn Silage—fed alone	79.64	5.49	11.96	21.86	54.73	5.96

TABLE XXIII.

WEIGHTS OF AIR-DRY EXCREMENT.*

	Sheep 1.	Sheep 3.	Sheep 4.
	grams.	grams.	grams.
Hay alone	1,302	1,350	1,311
Southern corn silage—fed alone	510	637.5	683
Southern corn silage and hay	852	946	963
Field corn silage—fed alone	531	507.8	504.4
Field corn silage and hay	637	809	788

* For analyses see report of L. H. Merrill.

COMPOSITION OF THE MILK.

AVERAGES FOR EACH FIVE DAYS.

		Cow 1.		Cow 2.		Agnes.	
		Total solids.	Fat.	Total solids.	Fat.	Total solids.	Fat.
Period 1	First half	12.45	3.69	12.86	4.14	14.19	4.34
	Second half	12.38	3.57	13.13	4.00	13.86	4.35
Period 2	First half	12.58	3.81	13.13	4.14	13.65	4.43
	Second half	12.26	3.71	12.92	4.06	13.70	4.57
Period 3	First half	12.81	4.03	13.24	4.21	14.34	4.50
	Second half	13.2	4.36	13.37	4.31	14.94	4.59

FOOD CONSUMED, MILK YIELD, WEIGHT OF COWS AND COMPOSITION OF MILK.

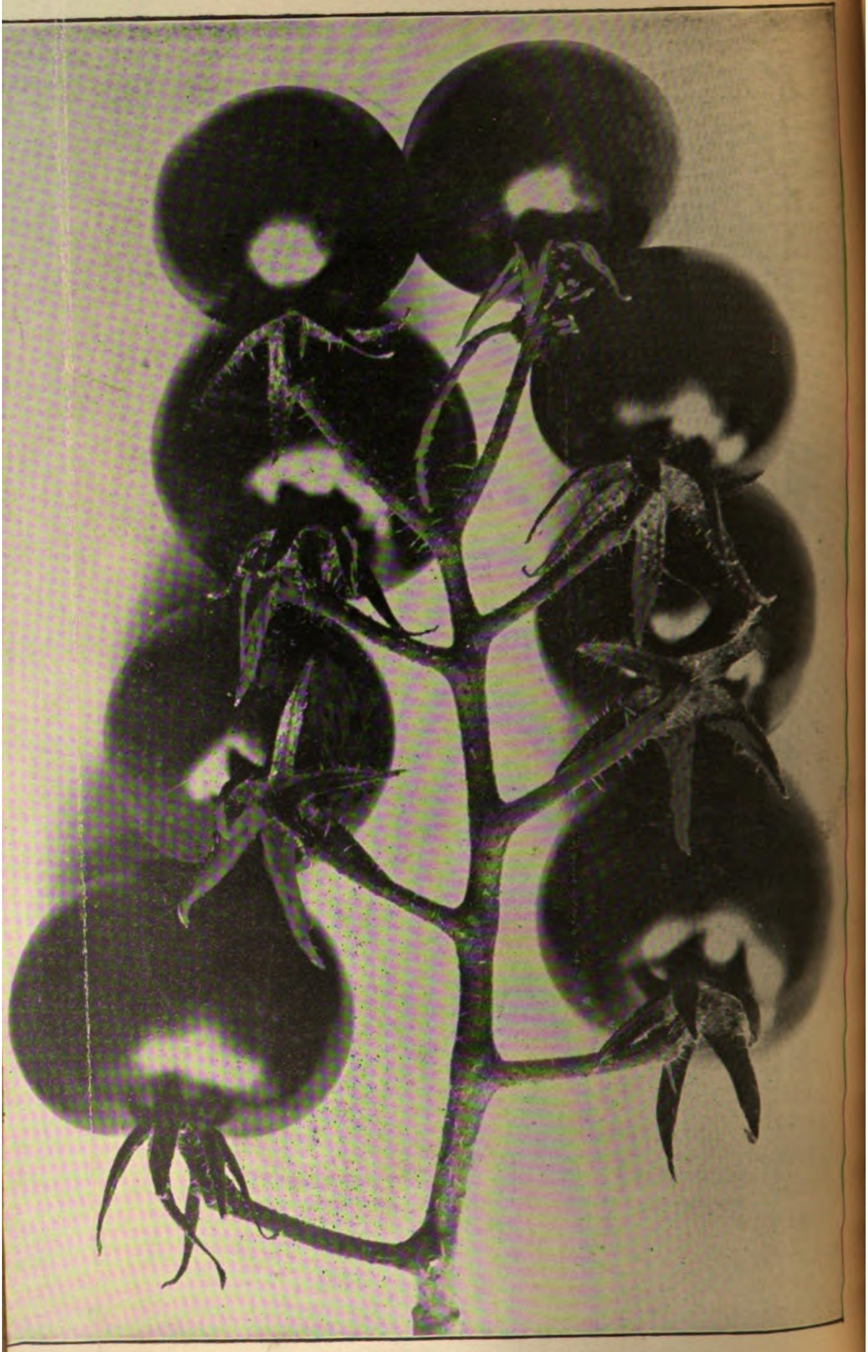
FIRST PERIOD—28 days.		Hay eaten—pounds.	Silage eaten—pounds.	Grain eaten—pounds.	Live weight at end of period—pounds.	Yield of milk—pounds.	COMPOSITION OF MILK.	
							Per cent solids.	Per cent fat.
First half, 14 days,	Cow 1,	182	350	98	727	407	12.44	3.69
	Cow 2,	182	350	98	758	309	12.86	4.14
	Agnes,	210	350	98	847	320	14.19	4.54
Milk yield first half						1,036		
Second half, 14 days	Cow 1,	182	350	98	727	399	12.38	3.57
	Cow 2,	182	350	98	763	338	13.13	4.00
	Agnes,	210	350	98	850	319	13.88	4.56
Milk yield second half						1,056		
Total milk yield						2,092		
SECOND PERIOD—28 days.								
First half, 14 days,	Cow 1,	112	350	98	674	381	12.52	3.81
	Cow 2,	112	350	98	720	323	13.13	4.14
	Agnes,	140	350	98	798	305	13.64	4.63
Milk yield first half						1,009		
Second half, 14 days	Cow 1,	112	350	98	670	334	12.26	3.71
	Cow 2,	112	350	98	732	295	12.92	4.06
	Agnes,	140	350	98	814	278	13.70	4.67
Milk yield second half						907		
Total milk yield						1,916		
THIRD PERIOD—28 days.								
First half, 14 days,	Cow 1,	182	350	98	716	293	12.80	4.03
	Cow 2,	182	350	98	770	288	13.24	4.21
	Agnes,	210	350	98	852	237	14.24	5.00
Milk yield first half						818		
Second half, 14 days	Cow 1,	182	350	98	725	317	13.20	4.36
	Cow 2,	182	350	98	771	310	13.37	4.31
	Agnes,	210	350	98	840	268	14.24	4.99
Milk yield second half						895		
Total milk yield						1,713		

The testimony of this experiment, as gained from observation of the animals and a study of the figures given in this connection, is unfavorable to the smaller ration of hay.

The withdrawal of the noon feed of five pounds of hay resulted in (1) a diminished flow of milk, (2) a loss of weight of the animals and (3) an appearance of unthriftiness in the cows.

To be sure the cows gave less milk during the third period, after the larger ration was restored than in the previous period on a smaller hay ration, but it was easy for the experimenter to see that the animals were using their food to recover from the depressing effect of an insufficient food supply. It is also noteworthy that during the last half of the third period the cows had not only recovered their loss of weight but had begun to gain in milk yield. The writer cannot resist the temptation to call the attention of those who believe that the ration largely controls the quality of the milk to the fact that although the cows lost flesh and diminished greatly in their product, the quality of the milk seems not to have been influenced.

Attention is also directed to the great variations that occurred from day to day in the quality of the milk, although no changes occurred in the food.



ATE I. A TOMATO HYBRID. (NATURAL SIZE.)

REPORT OF THE HORTICULTURIST.

HORTICULTURAL NOTES.

W. M. MUNSON, Horticulturist. H. P. GOULD, Assistant.

It has been the policy of the Horticultural Division from the outset to conduct work which should be of permanent value and to continue every investigation through a series of years. Each year's experience gives additional facts for the direction of investigation; the field is ever widening, therefore we have not completed any line of investigation and do not expect to do so.

In addition to our perennial studies it is our purpose to conduct a certain amount of work which shall have an immediate practical value to the farmers of the State. This work is mainly in determining the characteristics of different fruits and vegetables offered for sale, in applying approved methods of culture and in combating the insect and fungous pests of orchard and garden. The interest in this work on the part of the gardeners and fruit growers of the State, as evinced by the increasing volume of our correspondence and the demand for bulletins would seem to justify its continuance, but we would not lose sight of the main point, viz.: that principles are of more importance than isolated facts.

I—NOTES OF POTATOES.

The Rural New Yorker Trench System.

In 1893 a comparison was made between the ordinary furrow culture of potatoes and the so-called *Rural New Yorker Trench System.* From this work we concluded: "That it is questionable whether the results obtained will justify the extra labor involved in practicing the trench system. * * * Duplicate lots in every instance produced contradictory results."* This conclusion was afterwards called in question on the ground of too deep planting, though the criticism was without reason.

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*Rep. Me. Exp. Sta. 1893. p. 124.

During the past season the work was very carefully repeated on a more extensive scale. The land selected for the purpose was a strong clay loam, naturally moist, but thoroughly underdrained. The land was divided into two plots of one-twentieth acre each.

The variety used in this test was Early Rose. On each plot sixty pounds of a complete fertilizer were applied—broadcast for the common system; in the trench with the other.

The two plots were plowed and harrowed alike. One was then furrowed about four inches deep, and planted in the ordinary manner, the fertilizer applied on the surface.

On the other plot furrows eight inches deep were made. These were then pulverized to a depth of fourteen inches. They were then filled to six inches, after which the fertilizer was distributed in the trenches and covered with two inches of soil. The tubers were then planted in the same manner as on the other plot. The two plots were treated alike during the remainder of the season.

The results obtained from the two lots are shown in a table.

TABLE I.

Treatment.	Whole number of tubers.	Number of marketable tubers.	Weight of marketable tubers—pounds.	Number of small tubers.	Weight of small tubers.
Early Rose.					
Trench	**3,662**	2,077	**599.75**	1,585	**95.25**
Furrow	**3,311**	2,284	**682.25**	1,027	**64.00**

The total number of tubers was greater from the trenches, but the gain was wholly in those which were small and unmarketable. The average size of individual tubers from the two plots was not essentially different, but as seen in column four the number of salable tubers was much larger from the furrows,—there being a difference of 82.5 pounds on the plot. The tops remained green several days longer on the plot which was furrowed than on the other and this may in part account for the relatively large number of salable tubers.

The actual cost of labor in preparing and planting the two plots, after plowing and harrowing, was, for the trench system sixty cents and for the other thirty-two and one-half cents, or a difference of twenty-seven and one-half cents.

Reducing the results above detailed to the basis of one acre we have $5.50 as the increased cost of planting by the trench system with nothing to show for it,—on the contrary with an actual difference of 27.5 bushels in favor of the ordinary method.

We are thus led to the same conclusion as last year, viz.: Results do not justify the extra labor involved in the trench system.

II—Notes of Corn.

Except in our general studies of plant variation, corn has not received marked attention at this station. During the past year, however, several varieties were grown, and some notes concerning their behavior are given. The table indicates in the most concise way the more important points of general interest. All varieties were planted May 27th.

TABLE II.

VARIETY.	Date of first appearance of tassels.	Date of first appearance of silks.	Date of edible maturity.	Number of days from planting to edible maturity.	Relative yield—scale of 100.	Average height of stalks in feet.
Crosby	July 19,	Aug. 7,	Sept. 1,	**97**	60	6.5
Dreer's Extra Early	July 17,	July 24,	Aug. 15,	**80**	71	5.0
Early Cory	July 11,	July 24,	Aug. 14,	**79**	63	5.0
Early Minnesota	July 14,	July 27,	Aug. 25,	**90**	85	5.5
Marblehead	July 17,	July 24,	Aug. 15,	**80**	66	5.0
Moore's Concord	July 27,	Aug. 7,	Sept. 8,	**104**	58	6.5
Narragansett	July 14,	Aug. 2,	Aug. 25,	**90**	85	5.5
Nonesuch	July 27,	Aug. 9,	Sept. 19,	**115**	42	5.5
Perry's Hybrid	July 17,	July 31,	Aug. 28,	**93**	77	6.5
Stabler Pedigree	July 27,	Aug. 11,	Sept. 19,	**115**	52	7.0
Country Gentleman	Aug. 4,	Aug. 25,	Did not reach edible maturity.	....	....	5.5
Egyptian	July 31,	Aug. 19,		....	....	6.0
Ne Plus Ultra	Aug. 2,	Aug. 22,		....	....	6.0
Ruby	Aug. 4,	Aug. 24,		....	....	6.0
Stowell Evergreen	July 31,	Aug. 19,		....	....	7.0

As seen in Column 5, the varieties in the order of maturity were as follows: Cory, Dreer, Marblehead, Early Minnesota, Narragansett, Perry's Hybrid, Crosby, Moore's Concord, None-such and Stabler. For the average home garden we would select from this list Cory or Dreer for early use and Crosby or Perry's Hybrid for medium and late. The last named sort has been one of our favorites for general crop. As an early sort Dreer was somewhat superior to Cory in that the ears were larger and it was slightly more productive.

Column 6 represents the relative yield; the basis being the average number of ears per plant.

III—Notes of Tomatoes.

1. Historical—Our garden varieties of tomatoes belong to two distinct species,—*Lycopersicum pimpinellifolium*, Dunal, and *Lycopersicum esculentum*, Miller. The former is represented in the garden by the "Currant" or "German Raisin." This species is found wild in Peru and Brazil, but little is known of its history. It has not been modified by domestication and probably has not been long under cultivation. The chief value of this species aside from its use as an ornamental plant and to a limited extent for preserves, is in the breeding of new types, as suggested in previous reports.[*]

Lycopersicum esculentum, the ordinary tomato, is undoubtedly a native of Peru, but is spontaneous or indigenous throughout Mexico and as far north as Texas and California in a form closely approaching the cherry tomato of the gardens. So far as we know, it was first cultivated in the south of Europe. It is mentioned as early as 1561, while in 1583 the "fruit was eaten upon the continent dressed with pepper, salt and oil."[†] It was grown in England in 1597[‡] but for many years was used only for ornament. Even so late as 1819 only four varieties are named. [§]

Our own country was even later than England in beginning the general culture of the tomato. The fruit is said to have been introduced into Philadelphia by a French refugee from St. Domingo in 1798,[§§] and in 1806 McMahon writes: "The tomato is much

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[*] Report Maine Experiment Station, 1892. 68.

[†] Dodonæi, Stirp, Hist., 455.

[‡] Gerarde, Herballe, 275.

[§] Trans. London, Hort. Society, III, 347.

[§§] Manning, Hist. Mass. Hort. Soc. 40.]

PLATE II. FORCING TOMATOES UNDER GLASS.

cultivated for its fruit in soups and sauces . . . and is also stewed and dressed in various ways and very much admired."* It was introduced into Salem, Mass., about 1802 by an Italian painter Comé, "but he found it difficult to persuade the people even to taste the fruit."† The general culture of the tomato for market began about 1829.

The history of the introduction of our common varieties is a record of gradual change from the angular sorts of the Orangefield and Hundred Day type to the smooth apple-shaped type of to-day. The old Large Red of the earlier catalogues was followed in 1862 by Fiji Island and in 1864 by the Cook's Favorite. In 1866, Tilden appeared and then in rapid succession Maupay, Keye's Extra Early, Boston Market, General Grant, Trophy and Paragon.

Paragon was the first of the round or apple-shaped varieties to attain prominence, and its introduction gave a great impetus to the culture of the tomato as a field crop. It was a triumph for the application of correct principles of selection, for in the production of this variety the habit of a whole plant rather than the character of an individual fruit was considered.

In 1880, Perfection appeared and during the next decade, Favorite, Beauty, Dwarf Champion, Lorillard, Ignotum, and a host of similar excellent varieties have been put forward, till it would almost seem that further improvement may not be expected.

II—FORCING TOMATOES IN WINTER.

I have repeatedly called attention to the importance of the winter forcing of fruits and vegetables in supplying a growing demand. Each season during the past four years, we have grown with uniform success many of the more promising varieties, and have attempted to secure new strains and hybrids which would be of special value for forcing. Methods of culture have also received attention and the deductions here given are based on the most careful study of the plants in all of their relations.

General Cultural Notes.—Successful tomato culture under glass depends fully as much on the man in charge as on conditions. Eternal vigilance and the exercise of good judgment on the part of the grower are more essential than strict adherence to set rules. Strong bottom heat, plenty of light and a large volume of pure air are important conditions and are best secured in a large, well ventilated house. Bottom heat is not absolutely essential to success, but the crop matures much more quickly if given this condition. The house in which all of our work with tomatoes has been conducted is twenty by fifty feet and about eleven feet high at the ridge. The central bed is supplied with six two-inch hot water pipes; the flow being carried overhead to the further end of the house. The accompanying diagram—Fig. 1—represents a cross-section of this house showing the benches and the relative location of the hot-water pipes.

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*McMahon, Gard. Calendar. 319.

†Felt, Annals of Salem II, 631; cited by Manning, Hist. Mass. Hort. Soc. 40.

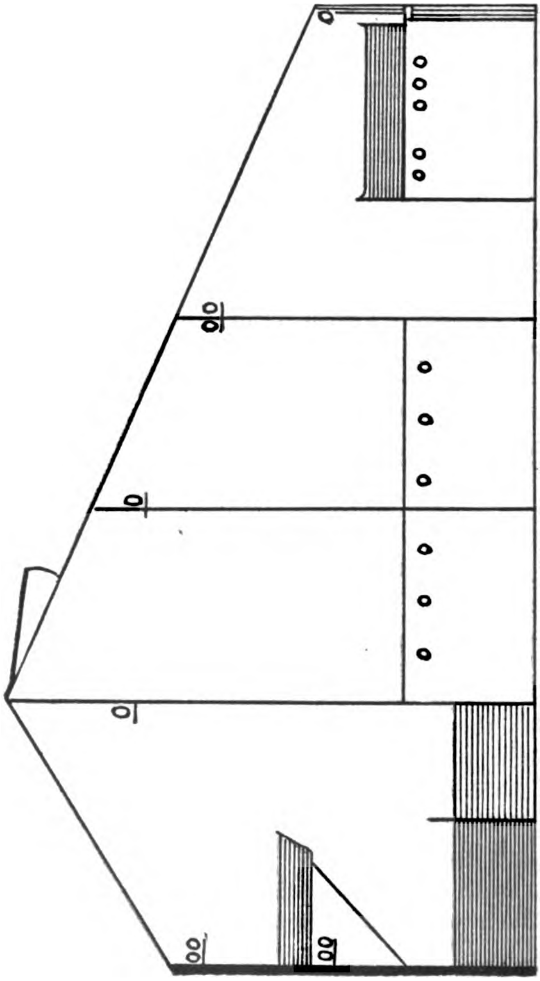

FIG. 1—CROSS SECTION OF FORCING HOUSE.

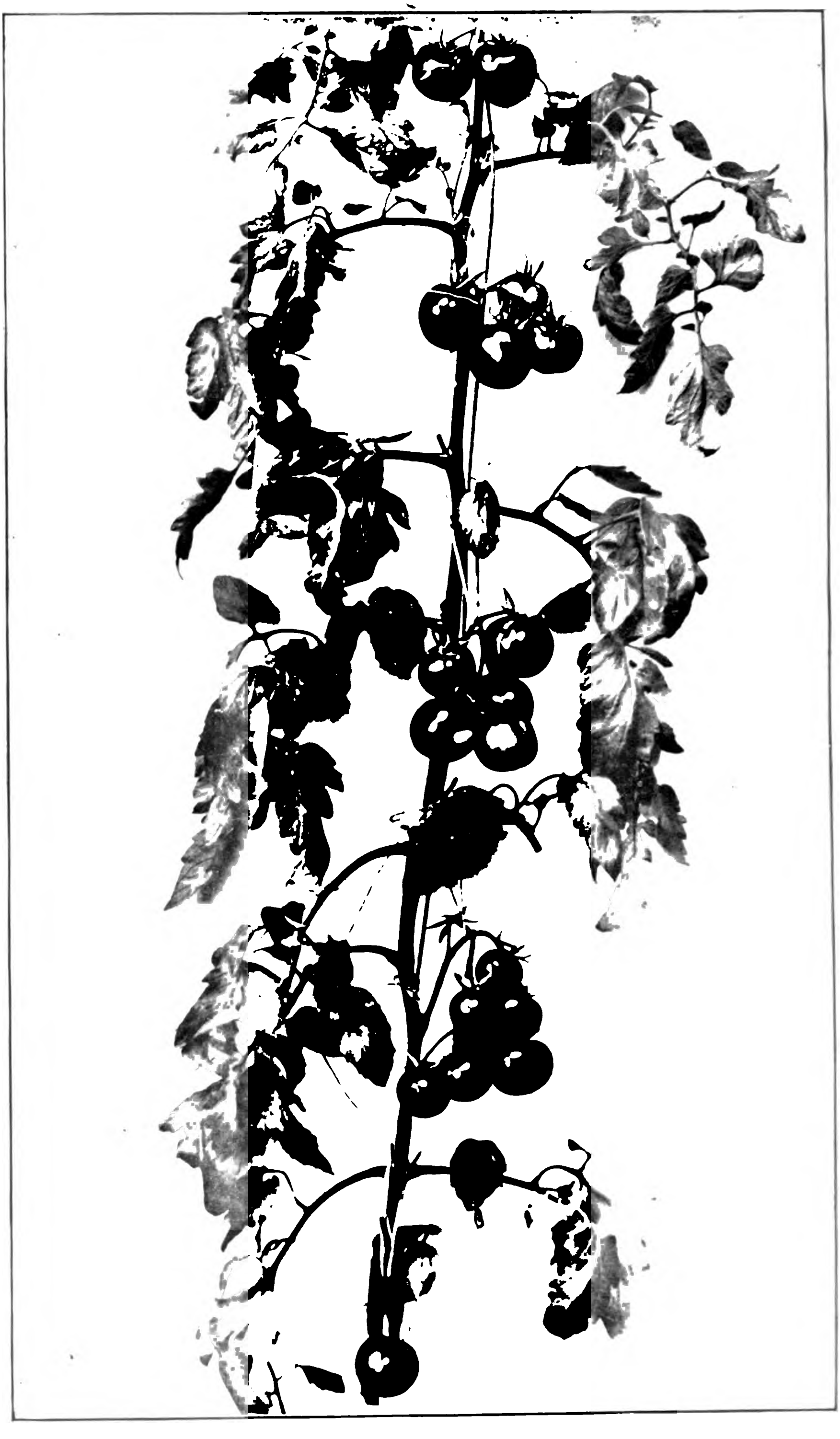

PLATE III. SINGLE STEM TRAINING (CHEMIN MARKET.)

To make the best use of the house two crops should be grown during the season. This will bring each crop on at a season when the expense of heating during a part of the time will be slight. Plants for the first crop should be started as early as the first of August, the middle of July being none too early if the bulk of the crop is desired for the holidays. In case two or more houses are available it is well to make a second sowing in about three weeks to give a succession. For the second crop seed should be sown about the first of November.

The plants are treated in every way as for out-door culture till handled the last time. For the final receptacle for fruiting we have generally used boxes eighteen inches square and one foot deep. In the bottom place a layer of about an inch of charcoal, potsherds or "clinkers" from the furnace; then fill to within two or three inches of the top with prepared soil, consisting of three parts good garden loam and one part well-rotted stable manure. Each box will hold four plants, and the check caused by the partial confinement of the roots seems to be of value in hastening maturity. This point is discussed in another connection (see page 57-59).

We have usually found the best returns to follow when the plants were trained to a single stem, as shown in Plate III.

Flax cords about the size of wool twine are fastened to the corners of the boxes and attached above to wires running lengthwise of the building on the rafters or sash-bars. The plants are secured loosely to this support by means of bast or raffia. All side shoots should be removed as soon as they appear. When the plants are about five feet high, or when about four clusters of fruit have set, the terminal buds should be pinched off. The vitality of the plant will then be expended in the development of the fruit.

As the fruit sets, the clusters should be supported by means of a small cord or piece of raffia passing around the main stem above a leaf, thus forming a sling. At this time, too, it is well to stir the surface of the soil and work in a quantity of well-rotted manure, or to give frequent applications of liquid manure.

The temperature of the house should be as nearly uniform as possible. We usually prefer about 60° at night and 70° in dark weather, but on bright sunny days the mercury may run up to 80° or higher. If possible, avoid cold draughts and sudden changes of temperature.

Until the plants begin to blossom, the atmosphere of the house should be kept moist and the soil, though not saturated, should never become very dry. Our practice, after the plants are removed to the fruiting boxes, is to water thoroughly about three time a week—less frequently in dark weather. On all bright days the walks and tables are thoroughly sprayed.

Some method of artificial pollination is usually found necessary. The best time to pollinate (fertilize) is about noon on bright days when the air in the house is dry. Tomato flowers are highly self-fertile, and the operation of pollinating consists simply in giving each plant two or three sharp taps with a padded stick. Some consider it necessary to attend to each individual flower, but we have always found the other method satisfactory.

A Comparison of Box Culture with Open Beds.—The writer has frequently expressed a preference for eighteen inch boxes in forcing tomatoes, on the ground that a reasonable confinement of the roots would tend to induce fruitfulness. Some extensive growers, however, maintain that the open bed or border is preferable; though all agree that bottom heat is always to be desired

Each year a dozen or more plants of each of several varieties have been grown in boxes as described on page 57, while duplicate lots have been grown in open beds. These beds were two and one-half to three feet wide and eight inches deep. They were built across the central bench and thus received the same bottom heat as the boxes. The following table represents in detail the results obtained:

TABLE III.

VARIETY.	FIRST CROP.				SECOND CROP.			
	First ripe fruit.	Number fruits per plant.	Weight of fruit per plant—pounds.	Average weight of fruits—ounces.	First ripe fruit.	Number fruits per plant.	Weight of fruit per plant—pounds.	Average weight of fruits—ounces.
1892-3.								
GOLDEN QUEEN.								
Box	......	......	......	......	April 24,	7	1.36	3.1
Bed	......	......	......	......	April 25,	7	.9	2.1
ITHACA.								
Box	Nov. 19,	9	1.4	2.5	April 11,	10	1.66	2.6
Bed	Nov. 23,	9.5	1.1	1.8	April 18,	8	.92	1.8
LONG KEEPER.								
Box	......	......	......	......	April 17,	13	2.12	2 6
Bed	......	......	......	......	May 6,	7.7	.8	1.6
*LORILLARD.								
Box	Nov. 21,	9.3	1.22	2.2	Nov. 21,	8.2	1.6	3.1
Bed	Nov. 23,	10.3	1.00	1.6	Nov. 23,	7.0	.95	2.1
1893-4.								
GOLDEN QUEEN.								
Box	Dec. 23,	12.5	2.32	2.97				
Bed	Dec. 16,	11	1.72	2.27				
ITHACA.								
Box	Nov. 9,	15.2	2.19	2.3	May 17,	10.9	1.69	2.47
Bed	Nov. 9,	16	2.25	2.25	May 16,	11.6	1.77	2.44
LONG KEEPER.								
Box	......	......	......	......	Dec. 25,	8.8	1.9	3.44
Bed	......	......	......	......	Dec. 9,	8.2	1.57	3.05
LORILLARD.								
Box	Dec. 16,	17.0	1.81	1.70				
Bed	Dec. 29,	8.7	1.28	2.34				

*Duplicate lots grown for first crop.

It will be observed that in almost every instance the better results were obtained from the boxes. With one or two exceptions, the first fruits were matured from one to thirteen days earlier; the weight of the crop was greater; and the individual fruits averaged larger.

The average results for the whole time may be summarized as follows:

TABLE IV.

	Number fruits per plant.	Weight of fruit per plant—pounds.	Average weight of individual fruits—ounces.
GOLDEN QUEEN.			
Box	9.8	1.84	3.0
Bed	9.0	1.31	2.2
ITHACA.			
Box	11.3	1.73	2.5
Bed	10.3	1.51	2.1
LONG KEEPER.			
Box	10.9	2.01	3.0
Bed	8.9	1.19	2.3
LORILLARD.			
Box	11.5	1.54	2.3
Bed	8.7	1.08	2.0

A Comparison of Plants from House and Field Grown Seed.—Attention has previously been called to the possible importance of conditions of growth of the seed in accounting for variation in the character of succeeding generations. It has seemed "possible that by forcing plants to early development in the house and by limiting the amount of fruit borne, a strain of unusual vigor may be produced." * With a view to throwing light on this subject several varieties have been grown under glass continuously and compared with the same sorts from seed matured in the open air each year, through succeeding generations.

The results are shown in Table III.

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* Rep. Maine Exp. Sta. 1893, 116.

VARIETY.	SECOND CROP 1892-3.			FIRST CROP 1893-4.		
	Average number fruits per plant.	Average weight of product—pounds.	Average weight of individual fruits—ounces.	Average number fruits per plant.	Average weight of product—pounds.	Average weight of individual fruits—ounces.
GOLDEN QUEEN.						
House	....	....	....	14	2.23	3.08
Field	....	....	....	13	2.32	2.97
ITHACA.						
House	5	.87	2.6	11	1.68	2.43
Field	10	1.66	2.6	22	2.45	1.74
LORILLARD.						
House	8	1.46	3.1	19	2.42	2.0
Field	9	1.30	2.4	17	1.81	1.7

VARIETY.	SECOND CROP 1893-4.			FIRST CROP 1894-5.		
	Average number fruits per plant.	Average weight of product—pounds.	Average weight of individual fruits—ounces.	Average number fruits per plant.	Average weight of product—pounds.	Average weight of individual fruits—ounces.
GOLDEN QUEEN.						
House	13	2.9	3.52	10	1.2	1.90
Field	14	3.0	3.46	12	1.1	1.53
ITHACA.						
House						
Field						
LORILLARD.						
House	13	3.2	3.83	11	1.3	2.1
Field	11	2.4	3.57	11	1.1	1.7

It will be observed that with the Lorillard, the average product per plant was always greater from the strain grown in the house, also that the individual fruits were larger. Ithaca, on the other hand, gave almost opposite results; while Golden Queen has from the first shown practically no difference. Unfortunately, before the above data were compiled, it was found necessary to drop one variety because of insufficient space. From the figures given, however, it would seem that there may be distinct varietal differences with reference to the point in question.

The Relative Merits of Different Varieties for Forcing:—Some varieties seem specially adapted for culture under glass, while others fail to give satisfactory results. Why this is so we do not know; but for the purpose of determining the most promising, we have grown several of the best known varieties for several seasons. Naturally, as the days grow longer in April and May the fruit will be of larger size and the product per plant will be greater than is the case with the first crop—in January and February. The figures given below—table VI—represent the average results obtained including both crops for several seasons.

Several other varieties—including Ignotum, Perfection, Peach, Prelude, Dwarf Champion, etc.—have been grown, but those named in the table have proved most satisfactory.

TABLE VI.

VARIETY.	Average number fruits per plant.	Average weight of product—pounds.	Average weight of individual fruits—ounces.
Chemin Market	12	2.29	3.0
Golden Queen	12	2.22	3.8
Ithaca	11	1.69	2.5
Long Keeper	10	1.86	3.0
Lorillard	13	2.05	2.7
Optimus	13	1.96	2.5

The ideal tomato for forcing should be of medium size—about two and one-half ounces preferred—and should be uniform, smooth, regular, and of firm texture. All things considered, Lorillard answers these requirements more completely than any other sort we have grown; though Optimus has usually done well. Chemin Market is very attractive in appearance, and is of good size, but it lacks solidity. Figures 2 and 3 represent respectively, extremes of solidity to be attained and avoided in a forcing tomato.

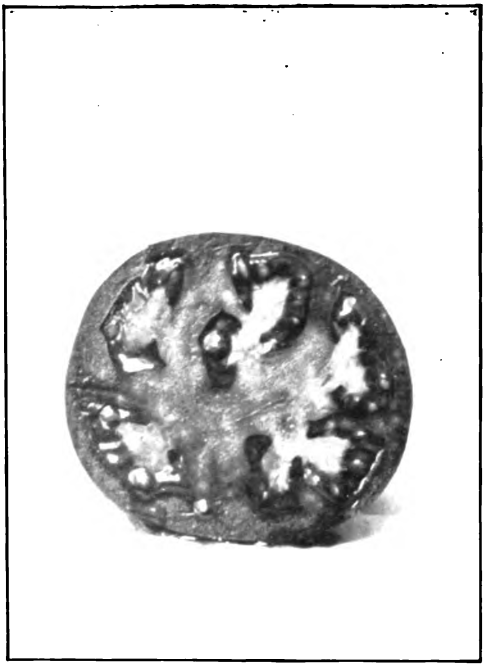


FIG. 2. IGNOTUM.

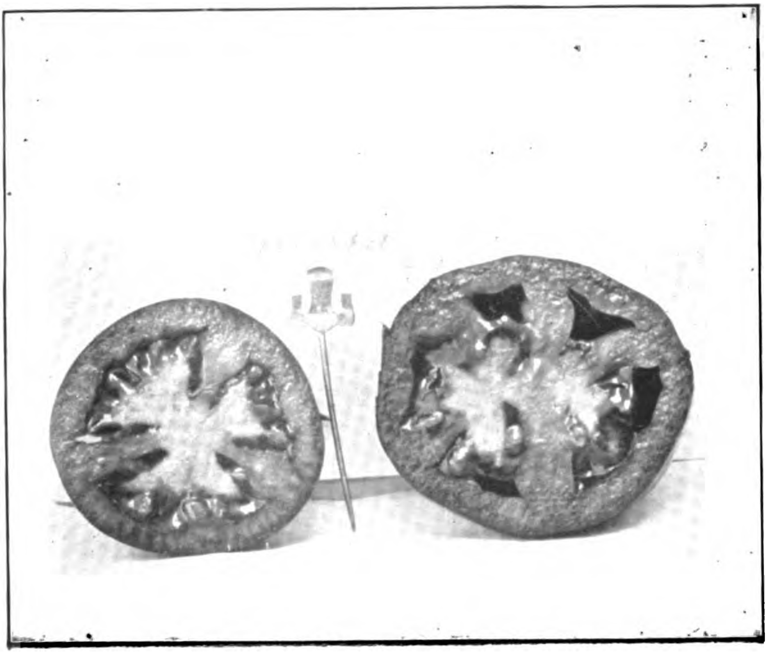


PLATE III. FIG. 3. CHEMIN MARKET.

No collection is complete without a few plants of Golden Queen. This is specially valuable for the pleasing contrast when served with the red or purple fruits.

As will be seen from the table the average yield varies with different sorts from 1.7 pounds to 2.3 pounds, per plant; the mean being about two pounds.

III—FIELD NOTES.

As in previous years cultural methods rather than variety testing received attention in the field.

Effect of Checking Growth before Setting.—The writer has frequently suggested the checking of plants likely to become drawn and "leggy" by cutting back before ready for the transfer to the field. Last season being somewhat cold and backward, there was an excellent opportunity for a comparison. On May 21, a dozen plants of each of three varieties were cut back about four inches and an equal number were left undisturbed for comparison. All were placed in the field May 29.

The results are seen in table VII.

TABLE VII.

VARIETY AND TREATMENT.	First ripe fruit.	Average number fruits per plant.	Average weight of fruit per plant—pounds.	Average weight of individual fruits—ounces.
ITHACA.				
Checked	Sept. 4,	**37**	**10.6**	4.9
Not checked	Aug. 15,	**45**	**14.8**	5.3
NICHOLSON.				
Checked	Aug. 27,	**63**	**12.7**	5.1
Not checked	Aug. 9,	**45**	**9.8**	3.5
OSCEOLA.				
Checked	Aug. 15,	**119**	**16.0**	2.1
Not checked	Aug. 4,	**72**	**9.8**	2.1

The Ithaca plants which were not cut back were superior to the others, but with the other two varieties the reverse was true. This difference is no doubt due to the fact that Ithaca is relatively a late variety, while the others are earlier. It will be seen that in every instance the plants which were cut back were somewhat delayed in maturing fruit, but the growth was enough more vigorous so that with sufficient time the crop exceeded that from the other plants.

Effect of Mulching.—The use of a mulch of straw or other litter as a means of conserving moisture has frequently been discussed. While our own practice is to employ frequent cultivation for this purpose, a comparison of the two methods of treatment was made for purposes of illustration.

Several plants of each of two varieties were placed in adjacent plots, May 29. On June 30, after both lots were well started one plot was given a heavy mulch of fine hay—lawn clippings—while the other was given the same cultivation received by the general plantation. The results are shown in the following table.

TABLE VIII.

TREATMENT.	First ripe fruit.	Average number fruits per plant.	Average weight of fruit per plant—pounds.	Average weight of individual fruits—ounces.	Per cent of fruit marketable.
DWARF CHAMPION.					
Mulched	Aug. 9	8	2.1	4.1	67.6
Cultivated	Aug. 13	21	5.9	4.5	86.9
CLIMAX.					
Mulched	Aug. 10	14	4.4	4.8	63.5
Cultivated	Aug. 13	43	13.6	5.0	72.1

The plants which were mulched matured a few days earlier than the others; but in every other respect those receiving cultivation were superior. The individual fruits were larger and nearly three times as many as from the other lot, were ripened before frost, while the per cent of marketable fruits was considerably higher.

Frequent vs. *Infrequent Cultivation.*—The importance of frequent stirring of the soil has often been emphasized. As a practical demonstration of the relative effects of thorough and "slack" culture, two lots of each of three varieties were planted side by side and were treated alike in every way except that after removal to the field one lot received only such cultivation as was necessary to keep the weeds in subjection. The soil was a light, sandy loam, and as the season was very dry during the latter part of July and August, the crop, especially from the later varieties, was very light. Table IX indicates the comparative results.

TABLE IX.

VARIETY AND TREATMENT.	First ripe fruit.	Average number fruits per plant.	Average weight of fruit per plant—pounds.	Average weight of individual fruits—ounces.	Ratio.
ARISTOCRAT.					
Frequent cultivation.............	Aug. 10..	14	3.9	4.5	**1.00**
Infrequent cultivation......	Aug. 10.	13	3.6	4.6	**1.08**
MAULE'S EARLIEST.					
Frequent cultivation.............	July 30..	22	8.1	5.4	**1.00**
Infrequent cultivation	Aug. 7..	32	11.6	5.9	**1.43**
TRUCKER'S FAVORITE.					
Frequent cultivation	Aug. 21..	9	3.6	6.7	**1.00**
Infrequent cultivation	Aug. 18..	6	2.2	6.5	**1.64**

The results are not conclusive. Two lots show decided differences in favor of frequent culture; while the third gives as decided indications the other way. It will be observed, however, that in both cases the later maturing sorts are the ones which are benefited by the culture, and it seems not improbable that the other variety, being naturally much earlier, was less affected by the drought.

SUMMARY.

1. The successful cultivation of tomatoes under glass demands good judgment and constant watchfulness on the part of the grower; a large well-ventilated and well-lighted house, the temperature of which can be easily regulated; strong bottom heat, rich soil, care in watering, attention to artificial pollination, and selection of the best varieties.

2. Better results follow the use of boxes than of beds as a receptacle for fruiting plants.

3. There is a marked difference in the adaptability of varieties for house culture, among the best of those tried being Lorillard, Optimus, Chemin, Golden Queen, Ithaca and Long Keeper.

4. The average product per plant should be about two pounds, or one and one-eighth pounds per square foot of floor space.

5. All things considered the Lorillard has proved the most satisfactory tomato for forcing.

6. Plants liable to become drawn and "leggy" before setting in the field may profitably be held in check by cutting back the tops.

7. Plants which were mulched matured a few days earlier than those receiving cultivation, but in every other respect the latter were superior.

8. There was not as much difference as was expected in the results attending frequent and infrequent cultivation.

IV—Notes of Small Fruits.

The culture of fruits is as a rule easier, cleaner, less expensive and often more profitable than that of vegetables. The requirements for labor and fertilizers are less, while with good care the crop is equally certain. From the very nature of the soil and climate of Maine we must look to intensive rather than to extensive operations for the most profitable returns, and at the present time there is no line of work which seems more promising than that of the culture of small fruits. In fruit culture, however, as in all other industries which are profitable, the man who uses his brains will always come out ahead of the one who depends wholly on his muscle. The successful grower must be an efficient, skillful workman, able to put his hand to any of the operations, but his best energies must be spent in planning and directing rather than in executing.

The essential elements of success in small fruit growing as a commercial venture are: Suitable location; thorough preparation; the best varieties; careful planting; thorough culture; the application of business principles in marketing.

THE STRAWBERRY.

A warm, rather moist sandy loam is usually preferred in growing this fruit, but in general any soil that will raise a good crop of corn will rise good strawberries. We would not be understood as encouraging neglect in any way, but the minute directions sometimes given for preparing the soil and for planting are misleading and are enough to discourage any novice from attempting to grow fruit.

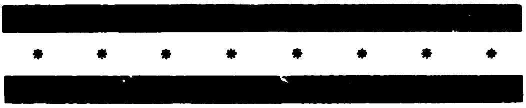
Thorough drainage, either natural or artificial, is absolutely essential, and thoroughness in the preparation of the soil is of prime importance, but the excessive applications of manure and the hand labor frequently advised are unnecessary. It is well to grow some hoed crop as corn or potatoes on the land for one or two years before setting the plants, as in this way there is less danger from attacks of the "white grub."

The month of May is, perhaps, the best time for setting strawberry plants in this latitude, though good results often follow fall setting. Two very important considerations in setting the plants are that the crowns be just even with the surface of the earth and that the soil be pressed firmly about the roots. These points cannot be too strongly emphasized, for to their disregard may be traced more than half the failures in starting new plantings.

For general field culture the "matted row" system is probably best. The rows should be as long as convenient, that most of the labor of cultivating may be performed with a horse. The plants should be set eighteen inches apart in rows which are about four feet apart. Thus placed, a little more than seven thousand plants will be required for an acre. During the first season thorough culture should be practiced. It is also well to keep the runners cut back till the parent plants are strong and well developed.

Winter protection of the plants is always advisable. The value of such treatement is two fold: Not only are the plants protected from injury, but the fruit is kept clean and bright. The best material for the purpose is coarse meadow hay cut before the seeds have ripened. We have sometimes used "shingle edgings" with very satisfactory results. In the vicinity of large mills this material may often be obtained much more cheaply than the hay.

On light gravelly soils we have sometimes resorted to the use of boards on each side of the row of plants as illustrated below:



This device is found a very satisfactory means of conserving moisture and will permit the growth of plants in locations which would otherwise be unsuitable. Naturally this device is recommended only for the home garden.

The question of varieties, although of great importance, is one which must be settled largely by individual growers; for the success of any variety will frequently depend on local conditions. It is always a good plan to have a trial ground for the newer sorts, as varieties of much promise at the Experiment Station may prove worthless in some localities.

In selecting varieties for planting it is well to bear in mind the distinction between the perfect flowering and the pistillate sorts. Many of our most valuable sorts are pistillate and must have some perfect flowering variety interspersed in order to secure the best results.

The following notes represent our estimate of the varieties fruited at the Experiment Station during the past two years:

Beeder Wood. (Perfect).—Small, spherical, uniform in size early in the season but soon "runs out." One of the earliest and most prolific sorts but of inferior quality. Plants quite subject to rust.

Beverly. (Perfect).—Large, oblong or spherical; of a rich dark color, moderately good quality, firm, prolific. A promising variety.

Bubach. (Pistillate).—Very large, irregular; of good color but poor quality, and lacking in firmness. Productive; valuable for near markets.

Charles Downing. (Perfect) —Of medium size, nearly spherical, moderately firm and of good quality. An old favorite for home use, but not as prolific as some others. Quite subject to rust

Crawford. (Perfect).—Large, nearly spherical, uniform and regular; productive and of good flavor, but too soft and too light colored for market.

Crescent. (Pistillate).—An old and deservedly popular sort; but rather small and not of high quality.

Cumberland. (Perfect).—Plants vigorous and prolific; fruits large and of good quality, but too light colored and soft for market. One of the best for home use.

Dayton. (Perfect.)—Medium to large, smooth and regular; of good quality but light colored and soft. Excellent for home use but too soft for market.

Epping. (Perfect) — Plants vigorous and prolific; fruit of medium size, roundish conical, uniform, bright red. A promising variety, received for trial from George Q. Dow, North Epping, N. H., under the name of "Yankee Doodle."

Gandy. (Perfect).—Of medium size, uniform, regular, firm and of good quality. Usually regarded as of special value as a late variety, but has not held its own with us.

Gen. Putman. (Pistillate).—Of medium size, but of pale color, soft and inferior in every way.

Gillespie. (Perfect).—Medium to large, oblong or conical, often with pronounced neck, firm, of good quality and color. One of the best sorts for general purposes.

Greenville. (Pistillate).—Medium to large, roundish conical, uniform, bright red, moderately firm and of good quality. Good for home and near market.

Haverland. (Pistillate).—Medium to large, oblong, regular, firm and of good quality. Plants strong and vigorous; free from rust. A very good sort for general purposes.

Jessie. (Perfect)—An early, sweet berry of good size. Oblong or conical, bright glossy red, handsome and of good quality. It has been one of the most satisfactory with us but is not uniformly reliable.

Jewell. (Pistillate). Of medium size and uniform; but soft and of light color. Not prolific.

Leader. (Perfect).—Medium size, roundish, bright red; fairly good quality. Only moderately productive.

Lovett. (Perfect).—Of the Crescent type. Early, prolific, but running small as the season advances and of second quality.

Michel's Early. (Perfect).—The earliest berry we have grown. Very productive, but small and of second quality. Blossoms very early and the flower trusses are short and well protected. Plants only moderately vigorous.

Mount Vernon. (Perfect).—Medium size, roundish conical, uniform. Of no special value.

Parker Earle. (Perfect).—Very productive, of large elongated fruit having a pronounced neck; firm and of good quality. The plants are very strong and vigorous, but send out few runners, hence should be planted thickly in the row. A valuable sort.

Princess. (Pistillate).—Plant strong, vigorous and productive; fruit a little dull in color, but large, nearly spherical, uniform, moderately firm and of good quality. Medium to late in season. One of the best general purpose sorts.

Sharpless. (Perfect).— Plants vigorous and prolific. Fruit large but somewhat irregular and not always ripening evenly. Of good quality and always reliable.

Smeltzer. (Smeltzer's Early). (Perfect).—Sent for trial by F. H. Smeltzer, Van Buren, Ark. Plants vigorous, healthy and productive. Fruit uniformly of medium size, oblong, firm, of dark rich color and good quality. A promising early variety.

Swindle. (Pistillate).—As grown on our grounds the variety is rightly named. Plants strong and vigorous but not productive. Fruit of medium size, light colored and of very poor quality.

Van Deman. (Perfect).—An early variety; small, spherical; of rich dark color and good quality, but soft and not productive.

Warfield. (Pistillate or with abortive stamens).—Moderately vigorous. Flowers small on short truss and well protected by foliage. Fruit of medium size, firm texture, moderately good quality; ripens evenly, holds its size through the season. Its deep rich color and productive habit make it one of the most valuable market sorts.

West Lawn. (Pistillate).—Sent for trial by C. P. Bauer & Bro., Judsonia, Ark. Plants very vigorous but not productive. Similar in general characteristics to "Cloud," which was sent out a few years ago.

The best of the older varieties above named are; Bubach, Crescent, Haverland, Sharpless and Warfield, with possibly Beeder Wood or Michel's as very early perfect flowering sorts.

Of the newer varieties the following deserve special mention: Beverly, Dayton, Epping, Gillespie, Greenville, Parker Earle, Princess, Smeltzer.

THE RASPBERRY.

The notes given concerning the character and preparation of the soil for strawberries will in general apply to the raspberry. As with the strawberry a rather moist sandy loam is preferred, but lack of such soil need not deter any one from planting. Thorough drainage is, however, absolutely essential.

As is generally known our cultivated raspberries belong mostly to two species—*Rubus occidentalis*, the black caps, and *Rubus strigosus*, the red varieties. A third species—*Rubus neglectus*, has furnished Shaffer, Caroline, and others of the "purple cane" tribe. This species is intermediate in character and habit between those already mentioned and has sometimes been regarded as a hybrid. The European species, *Rubus Idæus*, has also furnished some valuable sorts, such as Fontenay, Brinckle's Orange, Purple Antwerp, etc., but these varieties are not sufficiently hardy for northern latitudes.

The varieties of *Rubus strigosus* are very easily grown and for most purposes are more satisfactory than the black caps. The latter must be handled with great care at the time of setting or fully fifty per cent of the plants will be lost. It is specially important that the crown be placed not much below the surface of the soil. The red varieties, on the other hand, sucker so freely and grow so readily from root cuttings that no special care is required except to comb out the small roots and see that the soil is pressed firmly about the plants. It is well to dip the roots in water before setting—a direction which will hold good in setting any trees or shrubs.

Red rasperries should be set about four feet apart in rows six feet distant; thus requiring about 1,800 plants per acre. If kept in "hills" only five or six of the strongest canes should be allowed in each hill; but a practice very commonly followed is to allow a portion of the suckers to grow between the original plants, forming a hedge-like row.

Clean but shallow culture should follow transplanting. Go through the field with a cultivator as often as once in two weeks till the middle of August. It is, however, unnecessary to "hill up" around the plants. All suckers, except those desired for filling vacancies should be treated as weeds and should be hoed out as they appear.

Pruning is an operation which should receive attention. If done too late in the season, after the canes have become hard and woody, the result will often prove more disastrous than total neglect, as new shoots are developed and these fail to mature before frost. Our practice is to head back the young canes when about two and one-half feet high, and the laterals at about one to one and one-half feet. This method insures strong sturdy growth which does away with the necessity of stakes and trellises. The black caps are treated somewhat differently since longer canes are desired. These it is well to support with a stake.

Winter protection is indispensable with some of our best variaties. The operation, however, is very simple and inexpensive. It consists simply in removing a shovelfull of earth from the side of each bush, bending over the canes and holding them in place by a little earth or other weight. With red raspberries growing in solid rows our practice is to throw a slight bank of earth against the base of the plants, bend them over and lay an old rail or other timber over the tops. The snow will then drift in and afford all necessary protection.

There are at present about thirty varieties of raspberries in the Station garden, but many of these have not fruited and we shall at this time mention only those which have been thoroughly tested.

Cuthbert is perhaps the most satisfactory of the red varieties. The plants are vigorous and productive, succeeding in any reasonable location. The fruit is large and of fairly good quality, but late.

Golden Queen is a sprout from Cuthbert and resembes its parent in every way except color, which is a rich golden yellow. This variety should be in every collection for home use.

Hansell is one of the earliest red varieties. The fruit is of large size and excellent quality while the plants are hardy, vigorous and reasonably productive.

Marlborough is uncertain. Where it will succeed it is a valuable market sort, but the quality is inferior.

Rancocas is valuable because of its earliness. This variety ripens before the strawberries are gone, and is a good sort, but not firm enough for market.

Turner is a good sort for home use, but is too soft and rather small for market. The plant is exceedingly vigorous and hardy. It suckers more freely than almost any other sort.

Shaffer is the favorite variety for canning. Its color is unattractive, however, and it is not generally popular in the markets. It is of vigorous habit and is one of the most productive sorts we have, but is not quite hardy. Because of its value for preserving, and the lateness of its season it is well worthy of protection. It is propagated by tips like the black caps. .

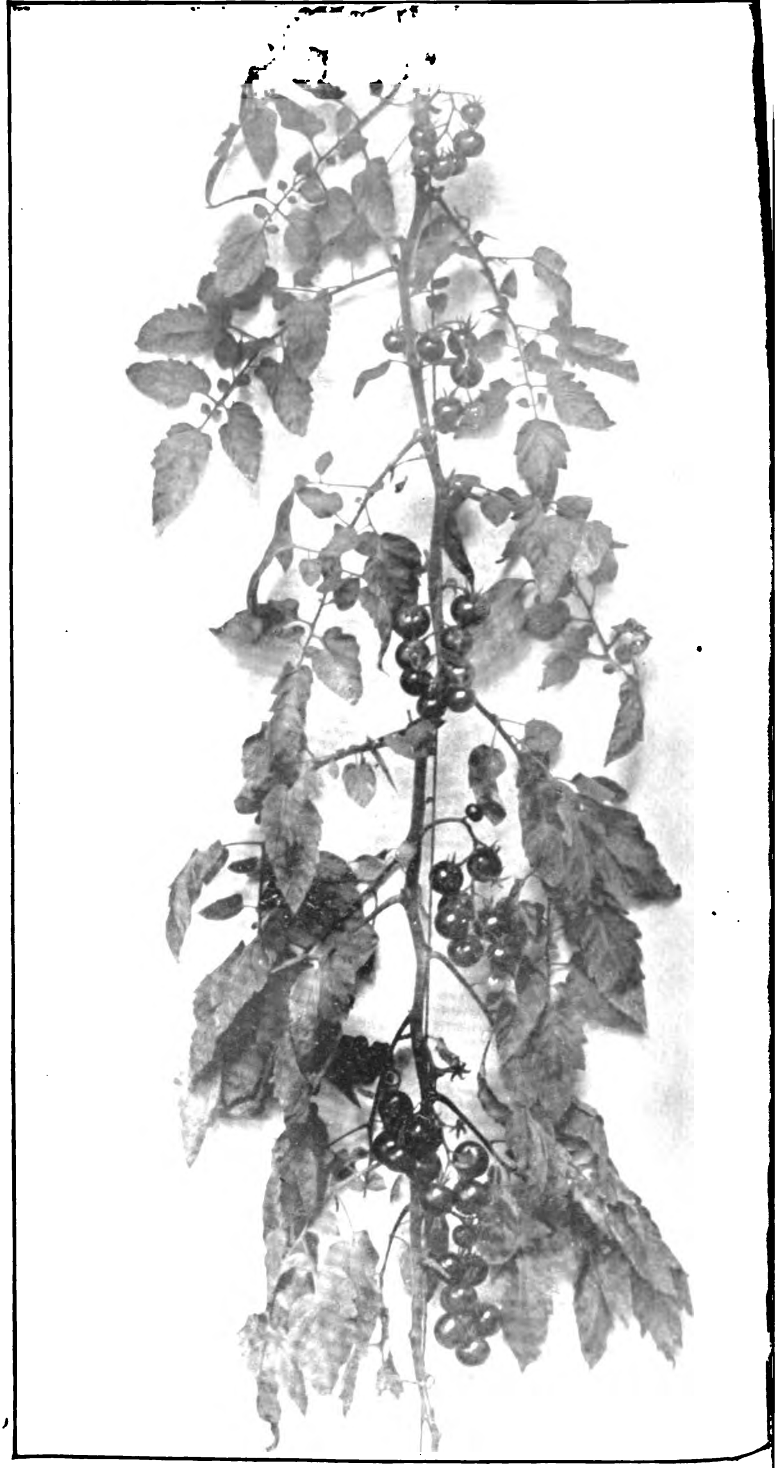
We have as yet fruited but few varieties of black caps, and do not advise their general culture.

Of those most commonly grown *Gregg* is perhaps the best. The fruit is large, and the plant is vigorous and productive, but is not quite hardy. A formidable rival of this sort is "Number 101" received for trial from G. C. Brackett, Lawrence, Kansas.

SUMMARY.

1. The essential elements of success in small fruit growing are: Suitable location; thorough preparation; the best varieties; the application of business principles.

2. Winter protection of some kind is always advisable.



LATE IV. LORILLARD × CURRANT (THIRD GENERATION).

3. Of the older varieties of strawberries tried, the best are ubach, Crescent, Haverland, Sharpless and Warfield, with possi-ly Beeder Wood or Michel's as very early perfect flowering sorts. f the newer varieties Beverly, Dayton, Epping, Gillespie, Green-ille, Parker Earle, Princess and Smeltzer are promising.

4. Of the raspberries thoroughly tried, Cuthbert, Golden Queen, nd Shaffer are the best for general purposes. The black caps are ot recommended for general culture.

NOTES ON PLANT-BREEDING.

W. M. MUNSON.

To many people the term "plant-breeding" conveys an indefinite idea of some "hobby" which may be attracting the attention of experimenters, and the immediate *practical* value of the work is not recognized. To meet the inquiries frequently received, a brief outline of the nature of our work in this direction is given at this time—a more elaborate discussion of reasons and principles being deferred until a later date.

There are about 107,000 species of flowering plants, and of these 4,233 species are known to have furnished food for man at some time—either habitually or during famine periods. Of this number about one-fourth are, or have at some time been, cultivated for human food. At the present time there are under cultivation to an important extent about 300 species. But many of these species present varieties almost without number. The apple and pear, for instance, have each given more than 3,000 named varieties; the potato nearly 1,000 varieties; wheat, 400; corn, 200; cabbage, 200; pea and bean each, 150, and other species from 10 to 100 or more.

Now the development of this great number of varieties and forms has been the gradual outgrowth in many cases of centuries of care and selection on the part of man. The apple, the pear, the bean, the cabbage, wheat and some others are known to have been under cultivation for more than 4,000 years, while most of our cultivated fruits and vegetables have been known for from 500 to 2,000 years. From the earliest times nature has been producing plants best fitted to meet the struggle for existence. Nature develops plants with the strongest constitutions and with organs best fitted for self-perpetuation, regardless of other features. It remains for man to develop those organs best suited to his needs, regardless of the natural requirements of the species, and to supply the environment necessary to the preservation of the plant. This has been done in some cases to such an extent that the species would be utterly incapable of existence if dropped from cultivation.

Very few plants now cultivated appear worthy of cultivation in the wild state. The radish, for instance, in its wild state closely resembles the wild charlock—*Raphanus raphanistrum*—a familiar weed throughout New England. The potato in its wild state gives hardly a suggestion of the modern White Elephants or Hebrons or Burbanks. The tomato, which has come into general use within the past hundred years, in its wild state is very small and insignificant, closely resembling the cherry tomato now grown mainly as a curiosity.

Necessity is an important factor in directing attention to the food value of a given species or to variations in form or habit which may be of importance. The continual demand made upon the producer for "something new" impels him to send to the uttermost parts of the earth for seeds and cions and plants to meet this demand. This interchange of plants and seeds is, from a practical point of view, of no small importance, and is deserving of careful study. Are seeds and plants grown in Maine better for local use than those grown in Massachusetts, New York or elsewhere? The question involves the general principle of *acclimatization*, and, indeed, opens a broad field for the study of the effect of climate on the variation of plants.

From the time of Lindley (1799-1865) many of the best horticulturists have contended that acclimatization does not exist; that plants can not be modified so as to be perfectly adapted to conditions not natural; that "all plants demand a particular climate—and we have no power over the constitution of the plant itself." One reason for disagreement on this point is that the true meaning of acclimatization is not borne in mind. The term is confounded with *hardiness* or with *domestication*. Acclimatization has been defined as the "state or condition of being inured, by the act of man, to a climate at first injurious." It differs from *acclimation* in that the latter is a *natural process* wholly independent of the agency of man.

But a slight modification due to changed environment is just as truly acclimatization as is a radical change, and at the present time there seems little doubt that acclimatization does occur. The change may occur through the modification of the constitution or habit of an individual plant or through variation of its offspring.

There is a very general opinion that a change in the individual plant is impossible. The truth can only be determined by growing the same plant in different climates. In general, if cuttings be taken from a certain plant to two other localities and from thence after a period of time, plants be taken to a fourth locality, if marked variations are found to have arisen, we must conclude that there has been a modification of the individual plant.

Again, it is well known that peach trees taken from Georgia to Virginia blossom several days later than do those of the same variety taken from New York or New Jersey. As the peach is propagated by buds, it is evident that the same plant has become modified in habit. It is not improbable that the same rule will hold in case of many if not most of our fruits and vegetables.

The method by which acclimatization most commonly occurs is through variation in offspring. The Russian fruits are illustrations in point. These fruits have been bred in a cold climate so long that they are much hardier than are other plants of the same species as grown elsewhere. The Russian apricot, for example, is simply a hardy race of the common apricot—*Prunus armeniaca*—yet it will often stand a temperature of thirty degrees below zero.

Careful observation of a field of beans or corn or tomatoes after a frost will reveal a marked variation in the hardiness of individuals. By selection from these plants hardier strains may be produced. Similar differences in earliness, in habit of growth, in quality, etc., may always be seen.

In other words, no two individual plants are exactly alike, and the application of the principles of selection is of the greatest importance in building up new and valuable types. The key to the whole matter, in the words of Darwin, is "man's power of *accumulative* selection. Nature gives successive variations; man adds them up in certain directions useful to him."

The highest step in the improvement of plants—that of cross breeding—is of comparatively recent origin. It is the climax of all effort in this direction, and to it we must look in our endeavors to secure hardy or otherwise desirab'e sorts of fruits and vegetables in the shortest possible time. It is in this way that we may hope to unite the quality of more southern varieties with the hardiness and productiveness of our northern sorts.

Any one can perform the mechanical operation of crossing plants, but the haphazard uniting of individuals is of little value. To breed plants intelligently we must have a distinct type in mind and work toward our ideal. In order to do this we must have some conception of the effects likely to be produced. The most prominent effects of crossing, as would be expected, are seen in the offspring; and it is of the greatest importance that care be used in the selection of parents. If the parents are very different in character the offspring will probably be weak. But the converse is also true: A cross between closely related species or races is more vigorous than its parent. It is well proved that "crossing is good for the resulting offspring because the differences between the parents carry over new combinations of characters or at least new powers into the crosses. It is a process of revitalization."*

The limits to which cross-breeding is either possible or profitable are not yet well understood. As a rule closely related species will cross readily while widely different species cross with difficulty; but this rule has very marked exceptions. It seems impossible to cross any of the varieties of winter squash—*Cucurbita maxima*—such as Hubbard, Sibley, etc., with varieties of summer squash or with the pumpkin—*Cucurbita pepo*;—while we feel safe in saying the cucumber and the muskmelon cannot be crossed.

In selecting parents the question naturally arises as to which shall be made the male and which the female parent in order to produce certain probable results. It was formerly held that in case of a hybrid the female parent gives constitution and vigor while the male parent gives form, size, color, etc. But at the present time it is generally conceded that the results will be approximately the same no matter which is used as the male or the female parent.

It is not always possible to select our male and female parents at will. In other words, reciprocal crosses are not always possible. For example, I may cross a yellow bush scalloped squash with the summer crook-neck, but I have never yet been able to cross the crook-neck with the bush scalloped. Other cases of a similar nature are not infrequent. Why is this failure? Is it due to a constitutional peculiarity; to the form of the ovarium; to a weakness of the pollen of the one species or variety, or what may be the underlying cause? The question is yet one of the unsolved problems.

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* Cf. Bailey, Cross Breeding and Hybridizing, p. 13.

There has long been a warm discussion as to whether on the parent fruit there are any immediate external effects of crossing. The evidence at hand at the present time would indicate that within certain restricted limits there is an immediate visible effect of pollen as seen in the pea, the bean and Indian corn. On the other hand it is equally certain that the greater portion of food plants which have received special study do not exhibit immediate effects of pollen. Thus this question remains another of the unsolved problems. Some preliminary notes on this subject and some of the other secondary effects of pollination have already been published.*

In all of the work outlined, the laws of heredity play a most important part, and form a legitimate field for investigation. Breeders of fine stock are not unmindful of the importance of pedigree; and in the vegetable kingdom as well as the animal, crossing and selection, combined with suitable environment and intelligent culture—in other words careful *breeding*—with certain fixed types in view afford a field for investigation which is of the highest importance in its bearing upon practical agriculture.

A record of the successive steps in the improvement, of the parentage, of each successive generation constitutes the *pedigree* of a given race or variety. In careful attention to the production of the foundation stock lies the future value of the race. "Pedigree" is of value as evidence of such care.

But "blood" and selection of parent stock alone are not sufficient Better individuals demand better treatment, and some individuals respond to favorable conditions more quickly than do others. So care in rearing is necessary to the maintenance of the type after it is reached.

The field is new and promising. The expense as compared with that attending stock-breeding is slight; while the results are more quickly known and are far-reaching in their value.

To insure the best results, however, we must first learn more of the laws obtaining in this branch of science; we must know more of the relations between cause and effect, that we may proceed along the most profitable lines. But in the search after laws we may employ plants of economic importance that, perchance, the preliminary work may not be without immediate practical value.

As a practical illustration we may cite the development of a new type of tomato which has attracted considerable attention. (The tomato was chosen for the investigation of certain principles because of the rapidity with which results may be obtained.)

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* Report Maine Experiment Station, 1892, pp. 29—58.

The ideal in mind at the beginning of our work with tomatoes was a smooth regular fruit of uniform size and early maturity, bears in large clusters on a sturdy vigorous plant. To this end a cross was made between the little Currant tomato (Fig. 4), which possesses the qualities of earliness, productiveness, and uniformity; and the Lorillard, (Fig. 5), which is of good size and vigorous habit. The resultant hybrid (Fig. 6) was described and figured in a former report.* This hybrid was again crossed with Lorillard for two generations. The prolific habit of the resulting product

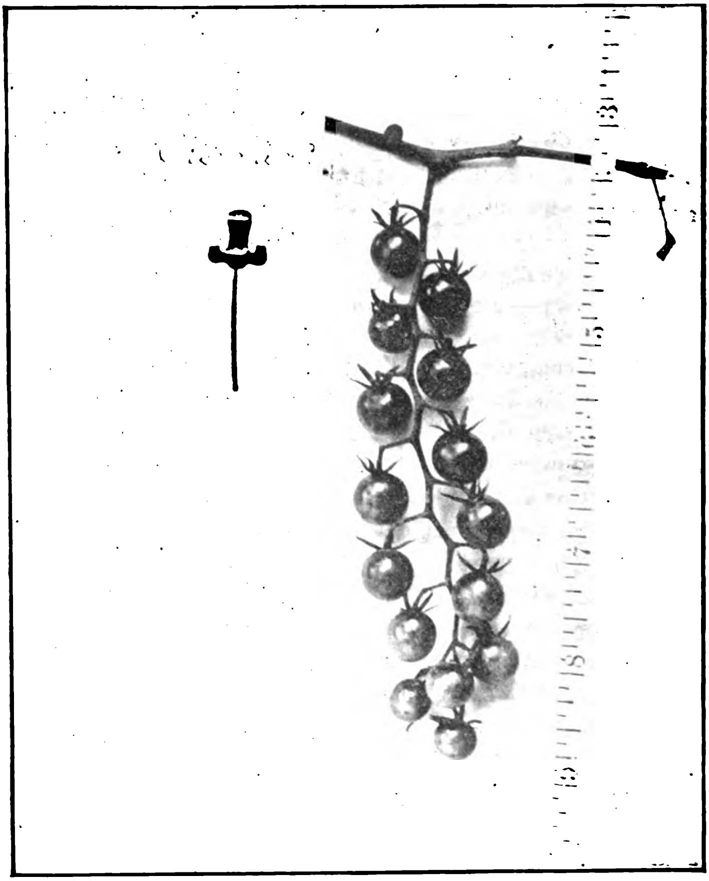

FIG. 4—CURRANT TOMATO.

is shown in plate IV and a cluster of fruit—natural size—from the same plant at plate I. We are now endeavoring by selection to "fix" the type, as we have found that further crossing with Lorillard tends to obliterate the effects of the original male parent.

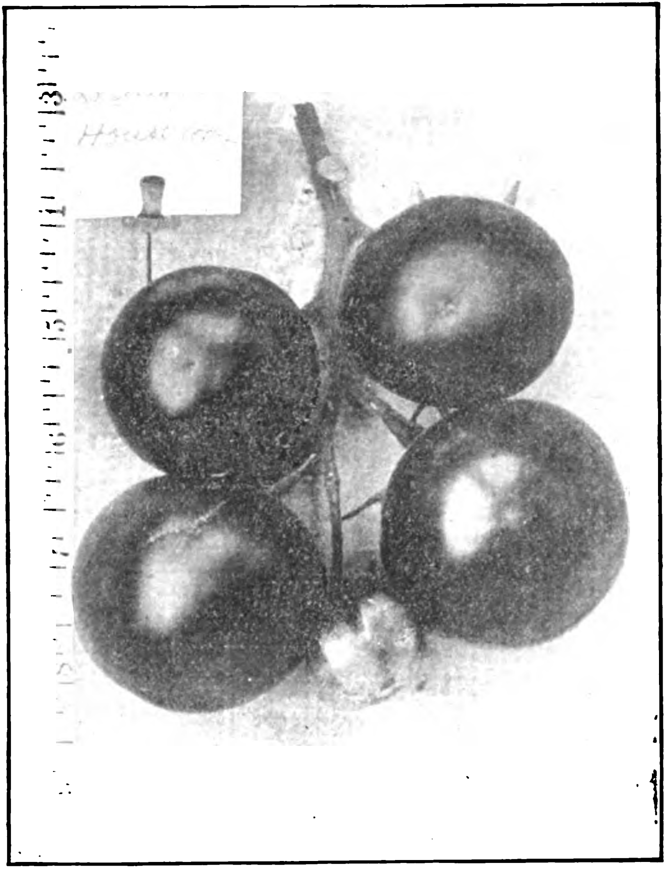

FIG. 5—LORILLARD.

What then is the ground covered in the general investigation of plant-breeding?

First—A study of the influence of environment, of the laws of heredity and of the principles of selection.

Second—The application of general principles in the production of new varieties of fruits and vegetables to meet special needs.

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*Rep. Maine Exp. Sta., 1892, p. 68.

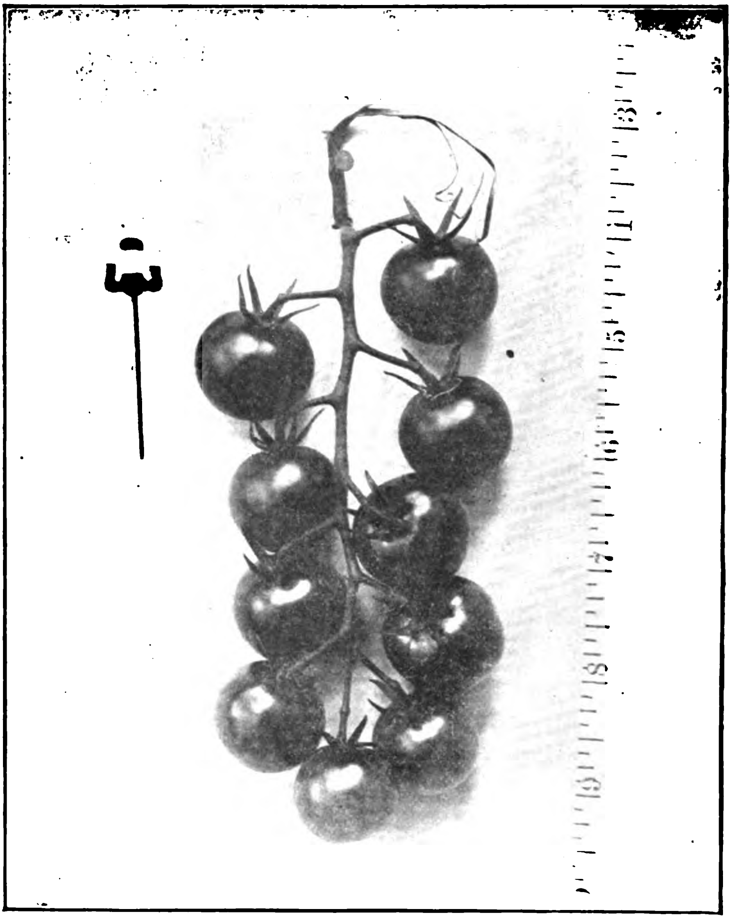


FIG. 6—LORILLARD X CURRANT.

Report of Botanist and Entomologist.

PROF. F. L. HARVEY.

Professor W. H. Jordan:

DEAR SIR—I have the honor to submit herewith my seventh annual report as botanist and entomologist for the Experiment Station. The correspondence regarding injurious insects and fungi, weeds, forage plants and seeds increases rapidly each year. It is gratifying to know that the work of the Station is becoming better known and appreciated. and that the Station is able to extend its usefulness in these directions. As but one-third of the writer's time is given to Station work the correspondence is rapidly encroaching upon the hours that possibly could be better employed making investigations in the field and laboratory. We fully realize that extensive and detailed correspondence must of necessity be an important feature of Station work, though it is only by original research that new facts can be added to entomological and botanical science. We do not desire to limit the correspondence, because the specimens received often are most interesting and important objects for investigation.

The duties of the season have been field work, laboratory investigations, lectures, preparation of articles for the State papers and Science Journals, correspondence and the preparation of this report.

By invitation of the Gypsy Moth Commission of Massachusetts, we visited Malden in July and spent three days in the offices, laboratories and field examining the methods used to fight this insect and submitted to the commission a report of our impressions. In September by invitation and courtesy of Mr. McKeen, we spent two days at Fryeburg examining the area infested by the chinch bug.

Investigations in the laboratory during the season have brought to light several species of insects new to entomological science, some new habits of well known insects, and additional information regarding the life histories and distribution of others. Some new fungi and weeds have been added to the State flora. Descriptions of some of the new species of insect were contributed to Entomological Journals, as the scope of Station reports is limited to matters of economic importance. We were called twice during the season to lecture before farmers' clubs and also delivered fifteen lectures to the winter students in agriculture upon Injurious Insects and Fungi.

Below will be found tabulated the more important plants and insects that have claimed attention. These tables are presented from year to year, as a record of the most important insects and plants claiming attention and are valuable for reference. Specimens new to the State, or of special importance are considered in detail and illustrated.

THE ORANGE RŒSTELIA has been very abundant the past season in southern and western Maine doing much damage to quince bushes. This fungus is considered in detail in the body of the report.

THE PEAR-LEAF BLIGHT which in our last report we stated was spreading in the vicinity of Portland has appeared this season in the Penobscot valley in the vicinity of Belfast and Northport.

The PEAR-TWIG BLIGHT (*Micrococcus amylovorus*, Burrill,) has also done some damage about Northport.

The BLACK KNOT continues to be reported and will no doubt be prevalent as long as bird cherry, laden with the knots, can be found on nearly every farm in the State.

INCONSPICUOUS HELMINTHOSPORIUM and COMMON CLADOSPORIUM, two fungus parasites, feeding upon the juices of the leaves and stems of oats, have been found to be the cause of their dwarfing and prematurely turning yellow.

THE YELLOW ROCKET or WINTER CRESS, FALSE FLAX or GOLD OF PLEASURE and *Berteroa incana*, DC, all plants of the mustard family (*Cruciferæ*) have been found in the State. The first two quite abundant. The third is mentioned as it is a weed new to the State, introduced in 1893 in clover seed. It is associated with THE DITCHOTOMOUS CATCHFLY a weed found in the State the past season for the first time and belonging to the pink family (*Caryophyllaceæ*).

THE CANADA THISTLE has been reported as a weed in meadows. It should be eradicated as quickly as possible.

THE ORANGE HAWKWEED as shown by the table, which gives new localities, is spreading rapidly.

THE FALL DANDELION *improperly called Arnica* is also spreading.

THE WILD CARROT is also increasing. We saw considerable of it last summer in meadows in western Maine. This is a biennial and should be pulled by the roots.

Authemis tinctoria. A relative of the may weed was received from western Maine and reported as quite abundant.

THE FLAX DODDER, (*Cuscuta epithymum*, Murr.) was found in some abundance in a clover field in Bradley. This parasite on clover, so far as we know, has not been before reported from Maine.

THE COMMON SNOW FLEA a small blue-black, wingless, jumping insect found on the snow on warm days in spring was received from Mr. McKeen. It sometimes collects on the surface of water or is troublesome by getting into sap tubs. These simple structured insects are believed by entomologists to be the lowest. They are like the earliest insects that were on the earth, the ancesters of the varied and complex forms of the present age.

THE SILVER MOTH (*Lepisma*) was reported from western Maine. This insect belongs to the same order as the snow flea (*Thysanura*) though quite different in habits. It feeds upon starchy and sugary matter and frequents closets and pantries often doing much damage.

THE RING-BANDED SOLDIER BUG was found preying upon the larvæ of the potato beetle. It is figured in the body of the report.

THE ELM TREE BARK LOUSE, *Lecanium Caryœ*, Fitch; *Var Canadense*, Cockerell. There is a bark louse of a mahogany brown color and hemispherical shell. It is very abundant upon elm trees all over the State and must do much damage. The branches in spring are sometimes literally alive with the young lice. These remain active all winter and develop the brown hemispherical scales over themselves the following spring. They can be found during the winter months as small oblong reddish brown objects lying close to the bark on the twigs. The leaves in early summer are often alive with them. The eggs are reddish and oblong. The scales are often punctured by parasites, probably a species of ichneumon, also a species of mite is often found under the scales in great numbers. We have had this species under observation every season for the past eight and there is hardly an elm tree in the vicinity of Orono but what is infested. The scales drop off sooner or later exposing a circular wooly patch. We received specimens from Mr. Moore of Presque Isle during the season showing its wide distribution. We sent specimens to Mr. Cockerell who pronounces it an undescribed variety. Mr. Cockerell has kindly sent us a MSS description which we incorporate in the body of the report.

There has been considerable complaint about an insect that destroys the terminal buds of gooseberry canes causing the growth of numerous small lateral shoots in a cluster near the ends of the branches. The specimens sent us this year and last were not accompanied by any live insects, but as the leaves showed numerous molt skins we concluded it must be the work of *Myzus ribes*, THE GOOSEBERRY PLANT-LOUSE.

THE CABBAGE BUTTERFLY (*Pieris rapæ*) is very abundant in Maine and interferes seriously with the culture of cabbage. There are various subtances that can be applied to check this pest, but none are effectual except *arsenical compounds* applied as spray, or in the form of powder. As arsenic is poisonous it should not be applied after the heads are a third grown.

We receive occasionally a large pale green moth with long tails to the hind wings. This is the LUNA MOTH, a night flying species, the larvæ of which feeds upon the walnut and hickory and no doubt other plants, as it is rather common about Orono and there are no native walnuts or hickories.

THE OBLIQUE-BANDED LEAF-ROLLER does considerable damage to currants and raspberries and other plants of the ROSE family.

We receive the CECROPIA EMPEROR MOTH so often that it is regarded best to publish cuts of this conspicuous species which feeds upon the leaves of apple trees.

The CHINCH BUG which is found over quite a large area in the vicinity of Fryeburg has done quite a good deal of damage annually to grass lands after haying for a great many years. It is not confined to the intervales about Fryeburg, but it has been reported from Bridgton on the east and from the vicinity of Bethel twenty-five miles to the north.

We received specimens of a HAWK MOTH known as (*Smerinthus cerysii*) from Mr. A. N. Townes, Winthrop, Me. This is a rare species and we mention it on this account. The early stages in its life history have never been published. We secured a large number of fertile eggs and have been able to rear the insects and make notes upon all the stages. Prof. Braun of Bangor, and Mr. Ora Knight, one of my pupils, have aided in the study. The notes will be contributed to some Entomological Journal. The species feed• upon the willow and poplar.

THE BUFFALO CARPET BEETLE is doing considerable damage to carpets in southern and western Maine, and has also been reported from Bangor and Belfast. We wrote an article for the Lewiston Journal on this insect, which is published in the body of this report.

The **MAPLE TREE BORER OF BEAUTIFUL CLYTUS**, a common insect in Maine, was received from Mr. McKeen and found in Augusta, about maple trees.

The **PEA WEAVEL** is very common in Maine. We figured this insect in our last report on page 175. This insect can be readily destroyed in stored peas by the use of **BISULPHIDE** of **CARBON**, as recommended for destroying the **BEAN WEEVIL** in our last report on p. 176.

THE BROWN GRAIN BEETLE (*Tribolium ferrugineum*, Fab.) was received from *Mr. Edward* of South Paris. The specimens were in middlings which were literally alive with them. It is a brown insect, oblong in form and about one-eighth to three-sixteenths of an inch in length. It frequents neglected grainaries, museums, kitchens and storerooms feeding upon both vegetable and animal matter.

THE OAK BARK BEETLE (*Magdalis olyra*) was received from Mr. Moore of Presque Isle where it was doing considerable damage to the foliage of elm trees. So far as we know this species has never been reported as an elm tree insect.

Those insects that require more than a passing notice and record are described more fully in the body of the report.

DIRECTIONS FOR SENDING SPECIMENS

Will be found in the Annual Report of the Experiment Station, 1888, p. 194, or in the Maine Agricultural Report, 1888, p. 158.

CORRESPONDENCE.

Correspondence regarding injurious insects and fungi is invited. Plants and insects will be named whether injurious, beneficial or neutral. When of economic importance their benefits or injuries will be pointed out and remedies for injuries suggested.

REMARKS.

The cuts to illustrate this report were obtained as follows: Fig. 1, loaned by Prof. Halstead; Figs. 7, 8 and 9, from J. B. Lippincott & Co.; Fig. 11, from U. S. Dept. of Agric.; Fig. 5, loaned by Prof. J. B. Smith; Figs. 2, 3, 4, 6 and 12 and Pl. 1, are after drawings made by the writer.

PLANTS REPORTED AND EXAMINED—1894.

No.	Common Name.	Technical Name.	From Whom Received.	Remarks.
1	Orange Rœstelia	*Rœstelia aurantiaca*, Peck	M. B. Whiting, East Northport... John A. Dennett, North Berwick,	Fungous disease upon quince trees affecting the twigs. Very common in southwestern Me. in 1894.
2	Pear Leaf Blight	*Entomosporium maculatum*, Lev	John G. Brooks, Belfast M. B. Whiting, East Northport...	Affecting the leaves of pear trees. For description see Ex. Station Report, 1892, p. 109.
3	Pear Blight	*Micrococcus amylovorus*, Burrell	M. B. Whiting, East Northport	Causing the twigs of pear trees to turn black and the leaves wither. See Me. Ag. Rep't 1889, p. 101 in Pom. Society Report.
4	Apple Scab	*Fusicladium dendriticum*	M. Wiggins, Bridgton	Causing scabby spots on leaves and fruit of apple trees. See Ex. Sta. Rep. 1888, p. 149, '89, p. 182, '90, p. 113
5	Black Knot	*Otthia morbosa* (Schw.), =*Plowrightia morbosa*, Sacc.,	John G. Brooks, Belfast John B. Holbrook, Peak's Island,	Infesting plum trees causing warty excrescences. See Me. Ag. Rep. 1889, p. 103 (Pom. Soc. Report.)
6	Inconspicuous Helminthosporium	*Helminthosporium inconspicuum*, C. and E., var. *Britanicum*, Grove. (Sacc. Syll. IV, p. 412,	B. Walker McKeen, Augusta Z. A. Gilbert, North Greene F. L. Harvey, Orono	Causing oats to turn yellow before maturity.
7	Common Cladosporium	*Cladosporium herbarum* (Pers.), Sacc. Syll. IV, p. 350,	F. L. Harvey, Orono	Causing oats to look sickly and early turn yellow.
8	Yellow Rocket—Winter Cress,	*Barbarea vulgaris*, R. Br	A. M. Piper, East Madison O. H. Perkins, Sanford	Weed in grass land. Weed in open damp fields.
9	False Flax, or Gold of Pleasure	*Camelina sativa*, Crantz	A. M. Piper, East Madison	Weed in grass land. See Ex. Sta. Report 1889, p. 185.
10	....	*Berteroa incana*, D. C.	C. H. Gould, North Bridgton, and many others in Western Maine,	Growing in grass land. Introduced in 1893. A bad cruciferous weed.
11	Night Flowering Catchfly	*Silene noctiflora*, L	F. L. Harvey, Orono	Weed on lawns and waste places.
12	The Dichotomous Catchfly	*Silene dichotoma*, Ehrb	From many persons and localities which are mentioned in the body of the Report	Introduced in grass seed in 1893, the weed maturing in '94. New to the State. Introduced from continental Europe.
13	Canadian Hypericum	*Hypericum Canadense*, L	Miss Helen M. Port, Kennebunk	For determination.

14	PURPLE AVENS	*Geum rivale*, L	O. H. Perkins, Sanford	In low meadows. A weed.
15	COMMON EVENING PRIMROSE	*Œnothera biennis*, L	E. B. Lufkin, East Orrington	Rank weed in fields and waste places.
16	SUNDROPS	*Œnothera fruticosa*, L	Stephen Larrabee, Dexter	Weed in grass lands.
17	SWEET SCENTED BED STRAW	*Galium triforum*, Mx	Miss Helen M. Port, Kennebunk	Weed in border of fields and wood land.
18	CANADA THISTLE	*Cnicus arvensis*, Hoffm	A. M. Piper, East Madison	Weed in grass land.
19	SUCCORY, or CHICORY	*Cichorium Intybus*, L	A. M. Piper, East Madison	Weed in grass land.
20	ORANGE HAWKWEED	*Hieracium aurantiacum*, L	F. L. Harvey, Brewer A. M. Lufkin, East Orrington Philip H. Stubbs, Strong Edwin E. Buker, Richmond Cor., Will P. Winslow, Larone	Weed in meadows and grass land. See Experiment Station Report, 1892, p. 106 (illustrated).
21		*Anthemis tinctoria*	C. H. Gould, North Bridgton	Related to the Mayweed. Weed in grass land. Also found in Penobscot Co. about Brewer in 1886.
22	ROUGH HAWKWEED	*Hieracium scabrum*, Mx	Miss Helen M. Port, Kennebunk	Weed in border of fields and open woods.
23	INDIAN PIPE—CORPSE PLANT	*Monotropa uniflora*, L	Mrs. A. M. Garland, South Dover	In pasture lands.
24	CLOVER DODDER	*Cuscuta Epithymum*, Murr	F. L. Harvey, Orono	Clover fields Bradley, Me. New to the State.
25	TURTLE-HEAD, SNAKE-HEAD	*Chelona glabra*, L.	Miss Helen M. Port, Kennebunk	Weed in low meadows.
26	NAKED BROOM RAPE	*Aphylon uniflorum*, Gray	Fred W. Cousins, West Kennebunk,	Moist soil by roadside.
27	MAD-DOG SKULLCAP	*Scutellaria galericulata*, L.	E. G. Knights, Waterboro	In low grass land. A weed.
28	CHESS, or CHEAT	*Bromus secalinus*, L	W. H. Keith, Winthrop	Weed in grass land and cultivated fields. See Experiment Station Report, 1891, p. 183 (illustrated).
29	YELLOW, or HOP CLOVER	*Trifolium agrarium*, L	S. H. J. Berry, Wayne	Weed on roadside. Poor for hay.

INSECTS REPORTED AND EXAMINED—1894.

No.	Common Name.	Technical Name.	From Whom Received.	Remarks.
1	Snow Flea	*Achorutes nivicola*, Fitch	B. Walker McKeen	Abundant in June about the roots of a tree. More often observed upon the snow in warm winter days or in the spring.
2	Silver Moth	*Lepisma Saccharina*, L	Mrs. Rose C. Johnson, Gorham,	Very abundant about the pantry. Eating sugar, paste, etc. Also does damage to books and clothing.
3	Ring-banded Soldier Bug	*Perillus circumcinctus*, Stal	Gustavus Pease, Bean's Corner,	Parasite upon the larvæ of potato beetles, piercing the larvæ with the proboscis and sucking out the soft parts.
4	Chinch Bug.	*Blissus leucopterus* Say	F. L. Harvey, Orono	Doing considerable damage to grass lands after haying, and also some damage to corn fields. Over a large area in the intervales about Fryeburg, Bridgton and Bethel, Me.
5	Elm-tree Bark Louse	*Lecanium caryae*, var. *canadense cockerell*	Delano Moore, Presque Isle	Coccid or bark louse. Very common on elms about Orono, Me.
6	The Gooseberry Plant-louse	*Myzus ribis*, L	Delano Moore, Presque Isle	Causing numerous small twigs to start from lateral buds near the end of the shoots, making a terminal bunch of small twigs and dwarfed leaves.
7	Hellgramite Fly	*Corydalis cornuta*	Geo. M. Pillsbury, Lisbon Falls,	The larva which was received by us is called "Dobson" by anglers, and is used as a bait for bass. It is found in ponds and streams.
8	Cabbage Butterfly	*Pieris rapæ*. L	Wm. J. Higgins, Fairfield.	Infesting cabbage. Lays its eggs upon cabbage, which hatch into cabbage worms.
9	The Luna Moth	*Attacus luna*	B. Walker McKeen	A night-flying species. The larva is said to feed upon the walnut and hickory.
10	Oblique-banded Leaf-roller,	*Cacœcia rosaceana* (Harris.)	Chas. S. Pope, Manchester	Attacking the leaves of currants and raspberries, causing them to roll.

12		*Smerinthus cerysii*, Kirby	Albion V. Towns, Winthrop	Found on Bracken Fern. Male and female mating. Food plant, willow and poplar.
13	THE BUFFALO CARPET BEETLE	*Anthrenus Scrophulariæ*	Geo. W. Jeffery, North Monmouth, and several other parties in Western Maine.	Destroying carpets, rugs and woolen garments.
14	THE BEAUTIFUL CLYTUS	*Clytus speciosus*, Say	B. Walker McKeen, Augusta	The larva boring in maple trees.
15	PEA WEAVEL	*Bruchus pisi*, L	E. T. Perkins, Saco	Doing damage to peas. Causing what are called "Buggy peas."
16	THE BROWN GRAIN BEETLE	*Tribolium ferrugineum*, Fab	Chas. Edwards, South Paris	Found in great numbers in middlings.
17	OAK-BARK WEEVIL	*Magdalis olyra*, (Herbst.)	Delano Moore, Presque Isle	Eating holes in the leaves of elm trees and hazel bushes. Very abundant.
18		*Thalessa lunator*, (Fabr.)	A. B. Ripley, Augusta	Boring into dead maple trees to lay their eggs. This is the largest of our Ichneumons. The ovipositor, fully two inches long. Parasitic upon the Tremex saw fly.

BOTANY.

THE ORANGE-COLORED RŒSTELIA OR QUINCE RUST.

Rœstelia aurantiaca, Peck.

Order *Uredineæ*.

The following letters were received during last July, in which were enclosed quince twigs affected by the above fungus.

EAST NORTHPORT, ME.,
July 25, 1894.

Prof. F. L. Harvey:

DEAR SIR—I enclose a twig from one of my quince bushes, having on it apparently some sort of fungous growth. On some of my bushes this has appeared numerously. It must be very injurious if allowed to grow. Will you please give me your opinion of it? In my limited reading on quince culture I have come across no reference to such a disease. Respectfully,

M. B. WHITING.

We wrote Mr. Whiting regarding the nature of the disease and below is given his interesting reply:

EAST NORTHPORT, ME., July 31, 1894.

Prof. F. L. Harvey:

DEAR SIR—Please accept my thanks for very full description of quince disease contained in yours of 27th inst. I knew of the rust, but was not before aware that it took the form of an excrescence on the twigs. In this case the cause of infection is undoubtedly to be traced to my cedar hedge, which extends in front of house, the quince is growing behind the house and separated from the hedge by it. The quince bushes are young, having been set only last year. The fungus did not appear until this season. The cedar, however, has no fungus on it, and its foliage is almost entirely free from rust or those dead, discolored twigs, which I presume is rust. I think it may be, as you suggest, that my quinces were already affected when I received them, as most of the Geneva, New York, nurseries, whence they came, grow arbor vitae. I had intended to go quite extensively into quince culture, as I think, barring disease, it could be made a success here; but unless I can prevent the rust of course it will be useless for me to attempt it.

Do you think that the Bordeaux mixture would prove effectual, both to cedar and quince? I do not wish to remove my hedge.

Respectfully,

M. B. WHITING.

We also received through Hon. B. Walker McKeen specimens of this same disease accompanied by the following letter from Mr. Dennett.

NORTH BERWICK, ME., July 15, 1894.

MR. SECRETARY—Inclosed I send for your inspection, a growth I find upon three quince trees, I bought from New York nurseries, and set last spring. One each of three varieties, Fuller, Alaska and Meech Prolific. They have started finely, but upon almost every twig there is a growth of this kind. I do not understand it, for it has never appeared on our Orange and Champions that we have had growing for years. Do you think it is anything like the black knot of plum trees that should be destroyed to prevent it from spreading? The trees have started thriftily, but it looks as though this would work their destruction. Can you please tell me what should or can be done with them? I dislike to destroy them unless it shall be necessary.

Very truly yours,

JOHN A. DENNETT.

In answer to some questions regarding the occurrence of cedar trees near Mr. Dennett's orchard we received the following, which strengthens the belief that the nursery stock was infected.

NORTH BERWICK, ME., February 5, 1895.

Prof. F. L. Harvey:

DEAR SIR—In answer to your esteemed note of 29th ult., will say that we have no cedar growth in this vicinity within miles of us, neither do I know of any cedar ornamental growth or hedges about here. The unaffected Orange and Champion were older trees which had been set several seasons, this fungus attacked the new set quince that I had from New York and New Jersey nurseries, (Green's and Lovett's,) hardly a twig of which escaped. I took the precaution to cut off and burn all the fungous growth and if it should appear again this season I will report to you, as it was entirely new to me and of which I am entirely unacquainted.

Very truly yours,

JOHN A. DENNETT.

As this fungus has been very abundant in southern and southwestern Maine during the past season, and is almost sure to appear again, we give for the benefit of all concerned the following account of the disease:

NATURE AND DISTRIBUTION.

This fungus has two stages in its life history, which are found upon very different plants. The *Gymnosporangium* or Cedar Apple stage, which occurs upon the Red Cedar and Low Juniper, members of the Order Coniferæ, and is known as *Gymnosporangium clavipes*, C & P. The *Rœstelia* or Rust stage (known as *Rœstelia aurantiaca*, Peck.) which occurs upon the Sugar Pear, (Amelanchier) Pear thorns (Cratægus), Choke Berry (Pyrus arbutifolia) and the cultivated quince and apple trees, all plants belonging to the Order Rosaceæ.

The first stage of the disease is probably as widely distributed as cedar trees and has been detected throughout the New England, Middle and most of the seaboard Southern States.

This stage of the disease is the *forerunner* of the *Rœstelia* or *Rust* stage, which cannot occur without it. The Red Cedar and Low Juniper are, therefore, responsible for the occurrence of the Rœstelia or Rust upon quince and apple trees. After the *Rœstelia* has become established in quince and apple trees it is *probably perennial*, that is, the mycelium may live in the twigs and produce spores from year to year.

The spores produced by the Rœstelia upon plants of the Order Rosaceæ can only grow when they find lodgment under proper conditions upon cedar trees, and then they produce the *gymnosporangium* stage or cedar apples.

The mycelium of the gymnosporangium is abundant causing the twigs of cedar trees to become swollen and much branched and the leaves to swell to double their natural size and become pointed and spreading. This is well shown in Fig. 1, A, which represents a diseased branch with enlarged and pointed leaves and bearing the reddish or brownish sporiferous masses. Fig. 1, B, shows a normal branch and Fig. 1, C, one of the ovate, two-celled spores which is germinating.

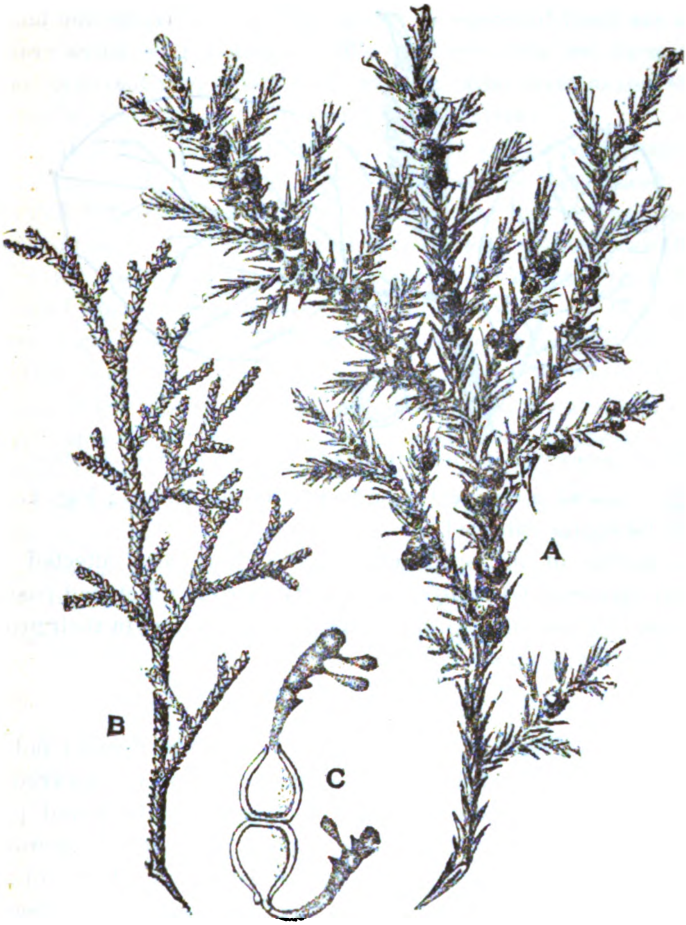


FIG. 1. A—Diseased cedar twig. B—Normal twig. C—Germinating spore.

At a distance this disease gives the appearance of birds' nests in the boughs. It is believed to be perennial.

The *Rœstelia* makes its appearance upon the young fruit and twigs of quince trees and other rosaceous plants early in the summer. It first sends its threads through the host producing orange spots in which pimples appear. From the top of these pimples short shining white horns (Peridia) are developed which are coarsely toothed at the top and contain the bright orange spores.

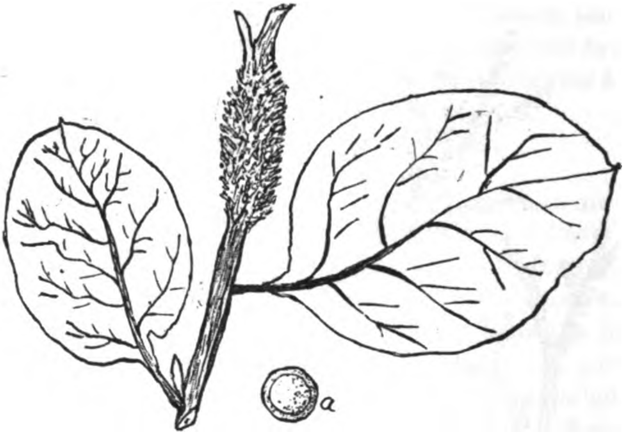


FIG. 2. Quince twig affected by Roestelia. a—Spore enlarged (original).

Fig. 2. shows a quince twig affected by the fungus; Fig. 2, A, one of its spores enlarged.

The leaves of the specimens received were also affected by another species of *Gymnosporangium* (G. *lacerta*) which had passed its prime. Those of *Rœstelia aurantiaca*, Peck, were in their prime when received in July.

REMEDIES.

1. As this fungus is perennial upon cedar trees it could not be killed by spraying with Bordeaux mixture. Possibly if sprayed at the time the spores were ripening they might be killed and prevented from being blown to quince and apple trees. This would be practical only upon hedges and ornamental trees. It would not be practical to spray forest trees. The rust stage of this disease is an *internal parasite* and has done its worst work when the orange patches and excrescences appear on quince and apple twigs, fruit or leaves. It would do the quince or apple trees no good to spray at that time. To spray early in spring when the spores from cedar trees are floating in the air would suggest itself as a preventive measure. To spray when the Rœstelia spores are ripe would probably destroy them and prevent the infection of cedar trees. There have been no spraying experiments tried with this disease so far as we know.

2. As the galls on cedar trees furnish the spores of this disease, all cedar trees in the vicinity of the orchard should be destroyed if possible. This would greatly lessen the chances of infection but

would not entirely remove the danger, as spores of fungi are sometimes carried long distances We have seen this rust upon sugar pear (Amelanchier) where there were no cedar trees nearer than a half mile, and they could be carried much farther.

3. It is probable that this rust is *perennial* upon quince and apple trees. The disease might, therefore, be introduced upon affected nursery stock and be very bad the first season after the trees are set. The experience of Mr. Dennett could be explained upon the basis that the Fuller, Alaska and Meech Prolific were affected when they came from the nursery, while the Orange and Champions escaped because there was no local cause of infection. If this supposition is correct the disease ought to disappear next season if the fungus is annual, or continue and not spread if perennial. It is the belief that *Rœstelia* spores will not spread the disease to other quince and apple trees. We will be much interested in the developments at Mr. Dennett's. There have been no carefully conducted experiments to prove whether the *Rœstelia* stage of this disease is *perennial* nor so far as we know to show *conclusively* that *Rœstelia* spores (æcidiospores) may not produce *Rœstelia* directly. Carefully conducted experiments are needed to settle these points.

4. It would be well to cut and burn the twigs bearing excrescences before the spores are liberated, and also to destroy all affected fruit.

DISEASES OF OATS.

Helminthosporium Inconspicuum, C. & E. *Var. Britanicum*, Grove.

During the summer of 1893 we received through Mr. Z. A. Gilbert specimens of oat plants which had turned prematurely yellow. We were informed that this condition was common in certain portions of the State. As we were unable to find any fungus at work we concluded *as the season was wet* that it was probably a case of malnutrition due to poor drainage and excess of moisture. This season the complaint was renewed by Mr. McKeen. The specimens he sent were found to be badly infested by a species of *Helminthosporium* which we submitted to Mr. J. B. Ellis who decided that it was the species named at the head of this article. It is described in Saccardo's Sylloge IV, p. 412. The type form of this species is reported from New Jersey and New York, upon living and languishing leaves of *Zea Maydis*. The variety is reported from Warwickshire England and so far as we know has not been reported before from the United States. The conidia of our specimens were 40—80x15 m m and 1—5 septate. See Fig. 3. Saccardo gives the dimensions 60—100x12x22 m m and 4—5 septate. The spores of our specimens are somewhat shorter and sometimes with less septa. This fungus is no doubt truly parasitic and capable of producing the languishing condition of the oat plants. In the specimens sent by Mr. Gilbert the disease had not progressed far enough to show the spore, masses which were dark brown colored and appeared as small dark dots or lines upon the leaves sent by Mr. McKeen.

Specimens taken from an oat field upon the college grounds that appeared to be similarly affected yielded, upon examination, another fungus known as

Cladosporium herbarorum (Pers.)

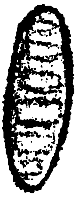
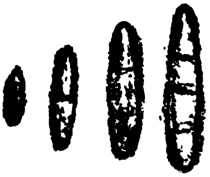


Fig. 3.


Original. Fig. 4.

The conidia of this species are 6—20X5—7 mm and without septa or 2—3 septate. This species is almost world-wide in distribution and attacks members of several botanical families. It is described in Saccardo's Sylloge IV, p. 350. The spores are shown much enlarged in Fig. 4.

The languishing of oat plants in Maine is, therefore, due to the combined action of the two parasites named above. As they are both *internal parasites* we know of no remedy for them. They would probably be much worse in wet. warm seasons and on low land.

NIGHT-FLOWERING CATCHFLY.

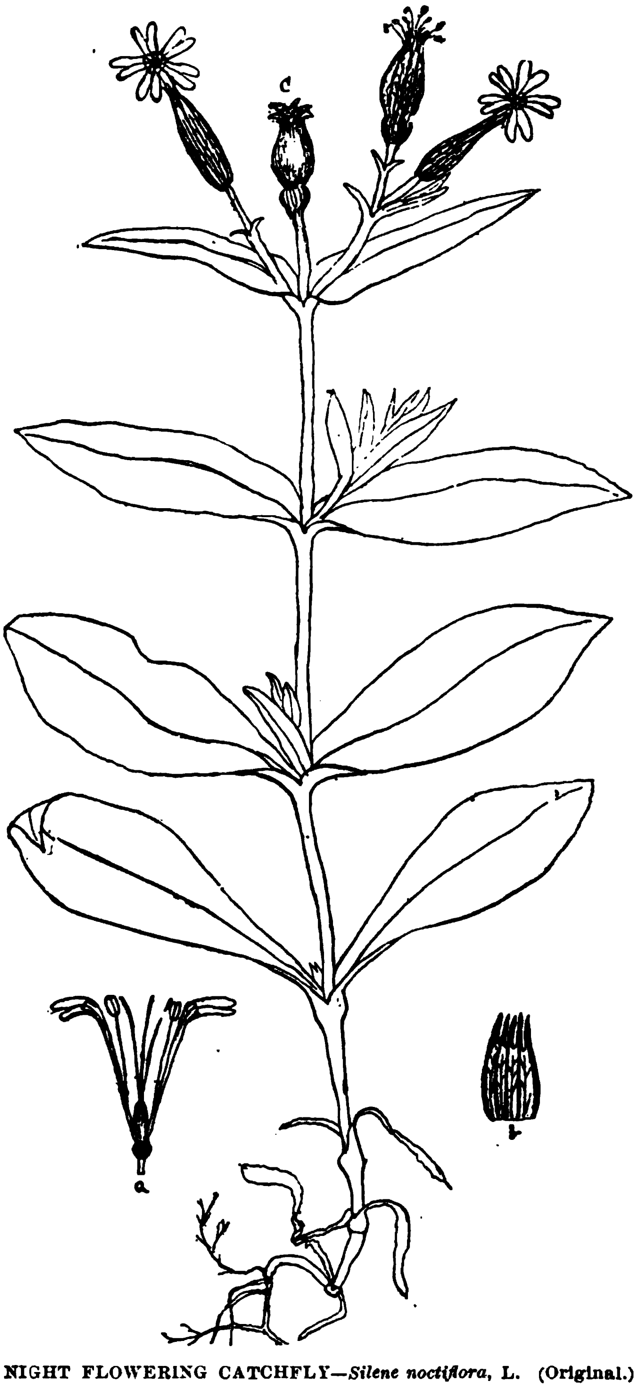
Silene noctiflora. L.

ORDER CARYOPHYLLACEÆ: PINK FAMILY.

This species of catchfly occurs sparingly in Maine in cultivated and waste grounds and roadsides. We found quite a number of specimens the past season upon lawns and waste ground in Orono, probably introduced in grass seed.

It is a coarse plant from three inches to three feet high, with viscid, pubescent leaves. The lower leaves spatulate; the upper lanceolate and pointed. Short, leafy branches, often from the axils of the opposite leaves. Flowers in loose cymes, pedicilate, and usually bearing a single flower, though sometimes more. The central flower of the inflorescence opening first

Calyx large after flowering becoming ovoid, greenish white with ten dark green nerves tending to anastomose, the teeth attenuate. Petals creamy white, often with a tinge of pink, bifid. Flowers about one-half inch across, bearing a ten-toothed crown, closing in the bright sunshine, but open in the shade and on cloudy days. Fragrant. Plant annual, though seeds from the early flowering ones soon sprout, and, we think, often blossom and seed before fall. The plate on the opposite page shows a plant reduced about one-fifth. (*a*) Cross section of flower. (*b*) Portion of calyx showing the anastomosing veins. (*c*) A mature capsule with the calyx removed showing dehiscence.



NIGHT FLOWERING CATCHFLY—*Silene noctiflora*, L. (Original.)

THE DICHOTOMOUS CATCHFLY.

Silene dichotoma, Ehrb.

ORDER CARYOPHYLLACEÆ: PINK FAMILY.

During the past season we have received specimens of the above catchfly from the following localities:

NAME.	ADDRESS.	KIND OF SEED SOWN.
D. B. Johnson	Freedom, Me	Clover, red top and herdsgrass.
Gustave Bellows	Freedom, Me	Clover, red top and herdsgrass.
Daniel Hustus	Freedom, Me.	Clover, red top and herdsgrass.
Frank Johnson	Freedom, Me	Clover, red top and herdsgrass.
Stephen Larabee	Dexter, Me	Red clover, alsike, herdsgrass.
B. W. Mitchell	Dexter, Me	Red clover, alsike, herdsgrass.
Horace S. Martin	Buxton Center, Me	Red clover, alsike, herdsgrass.
E. E. Light	Union, Me	Red clover, red top, herdsgrass.
Nelson W. Adams	Turner Center, Me	Red clover, red top, herdsgrass.
C. H. Gould	North Bridgton, Me	Red clover, red top, herdsgrass.

We also learn that this weed has been found at Farmington (C. H. Knowlton), East Livermore (Kate Furbish), Hartford and North Berwick (J. C. Parlin), and York (E. P. Bicknell.)

The above shows that this weed is widely introduced in Maine. We examined one lot of seed in 1893 that contained over a dozen bad weed seeds and among them the seeds of this catchfly. We condemned the seed. If wholesale dealers who import from other states or countries would receive samples and have them examined before purchasing and each wholesale dealer was required by state law to submit samples to a state inspector before retailing, the introduction of so many bad weeds could be averted. There were at least four bad weeds introduced in the State in 1893-4. It is to the interest of dealers to offer pure seed and they will probably not knowingly sell poor seed. To secure the selection of good seed the Station botanist will aid dealers and purchasers by inspecting samples submitted. From the record given above it will be seen that only one party sowed alsike and that one party who did not sow redtop had the weed, and that all who had the weed sowed herdsgrass and clover. The weed was therefore introduced either with herdsgrass or clover. As the seed of this catchfly is much larger than herdsgrass, darker colored, different shaped and with a rough surface, it would be easily detected in herdsgrass, while in clover seed it would probably escape detection by the casual observer. It was probably introduced with clover. The seed has been traced directly or indirectly to a single wholesale establishment. The seed was sold in 1893 and two years has elapsed and the dealer has no samples left and cannot tell where the seed was purchased, so it is impossible to trace it outside the State.

This weed was introduced in seed sown in 1893. It germinated that season, lived over winter and bloomed in 1894. After the grass was cut in 1893 the young plants of this weed were abundant proving it to be a winter annual or biennial. The following letter from Mr. Adams gives the facts regarding the introduction of the weed which are confirmed by the other correspondents:

TURNER CENTER, MAINE, July 4, 1894.

Prof. F. L. Harvey:

DEAR SIR—Last year I purchased enough grass seed to seed down an acre and three-fourths. The seed was a mixture of timothy, redtop and clover and was sown with barley on one piece, and with hungarian grass on another. After the grain and grass were removed in the autumn, I saw a great number of plants growing with the young grass and I thought they were oxeye daisies, judging by the form of the leaf, but when it headed and blossomed I found it was something entirely new to me and to every one to whom I have shown it.

I took a plant to Mr. Lyman Abbott, the agricultural editor of the Lewiston Journal. He didn't know what it was and never saw anything like it before. To-day I saw Mr. Z. A. Gilbert and was talking to him about it, and he said if I would send à stalk of the plant to you, I could find what it was and all there was to learn about it. I have seen fourteen or more stalks growing from one root, and the plants on the entire field are as near together as one on every square yard and on much of it as near as one on every square foot; now I am anxious to know if it will spring up from the root after it is cut this year, and if it is a plant that cattle will eat after it is cut and cured as hay, and if they will eat it, if it is healthful or injurious in case they will eat it.

If you can give information on this subject, you will not only oblige me, but a great number besides myself who are engaged in the same business. I am very respectfully yours,

NELSON W. ADAMS.

DESCRIPTION.

This species of catchfly introduced from Europe, is closely related to the *Night Flowering Catchfly* already described. It may be known by the followning description:

Tall, two to four feet high, more or less clothed with hairs, often reddish and viscid. Probably winter annual or biennial, often over *fifteen* stems from a single root and dichotomously branching toward the top where they bear the one-sided racemose inflorescence. Leaves lanceolate or oblanceolate, those at the base of the flowers near the ends of the branches, small, reddish, three nerved, scarious margined and about half the length of the flowers. Flowers short, pediciled, or nearly sessile, about five-sixteenth inches long; calyx, cylindric in flowering, becoming ovoid in fruit, the ten *bright green nerves* which run from the base to the tips of the lobes strongly hirsute along the back and with *no anastomosing veins*. Diameter of flowers one-half inch, petals white or roseate, obovate, deeply bifid and bearing at the base a two lobed scale which with the others form a crown.

The beautiful seed broadly kidney shaped, light brown, 1.33 mm. × 1.06 mm. Its surface densely covered with elevations arranged concentric and radiate from the hilum. Those near the hilum narrow, smaller. darker, smooth, bordered and unmarked. Outward from the hilum the papillæ become larger, more conical, oblong, bordered by from 10 to 20 teeth and bearing at the summit a round black dot. The teeth of the contiguous papillæ often interlock.

This species can be told from the other catchfly which we figure by its numerous stalks from the same root, its greater height and more slender growth, dichotomous racemose inflorescence, nearly sessile flowers and the veins of the calyx, which do not have branches running across from one to the other.

TREATMENT.

This plant is a winter annual or biennial. The seed sown in 1893 sprouted that year and the young plants lived over winter, and after producing flowers and seed in 1894 died *root* and *branch*.

Of course the best way would be to have seed inspected and reject all that contained the seeds of bad weeds. As this is not practical at present, farmers will be compelled to sow such seed as is offered to them and fight the weed pests that appear. With this particular one nothing could be done the first season. If the plants are prevented from seeding the second season that is the end of them. Some have gone to the trouble of pulling the plants up by the roots, believing the roots to be perennial. This was unnecessary, but the tops should be cut to prevent re-seeding.

Some of the specimens received about the first of August were fully seeded and the seed capsules open. If cut in that condition many of the seeds would be scattered. The plant should be cut as soon as the flowers begin to appear or before. The plant stools badly and each stalk bears several flowers and each capsule has numerous seeds. A few scattering plants would, if neglected, seed a field abundantly. We have had no experience, but doubt whether this weed would make hay. Those who have neglected to cut this weed carefully or have cut after the seed were ripe may expect to see it next season.

POTATO SCAB.

Botanists are agreed that this disease of the potato is caused by a fungus parasite, *Oospora scabies*, Thaxter. That the germs of a fungus will retain their vitality in the soil for several years.

That seed free from the disease will produce a scabby crop if planted upon soil contaminated with the germs.

That scabby seed planted upon soil free from the disease will produce a scabby crop.

That probably the disease is modified by the moisture, fertility, composition and mechanical conditions of the soil.

The source of the disease would therefore be either the *soil* or the *seed*. Conditions could never cause the disease; the germs must be present either in the seed or in the soil. To prevent contamination from the soil potatoes or beets should be grown upon *new* land, that has never grown potatoes, or if upon old soil, that which has not grown potatoes for a number of years. To prevent contamination from seed it should be selected from a field known to have been free from the scab.

If the origin of the seed cannot be determined then select the tubers that appear free from the disease, and soak them for an hour and a half in a solution of corrosive sublimate or Bordeaux mixture, to kill any germs present.

EXPERIMENT.

To test the efficacy of treating the seed with corrosive sublimate we took some potatoes that were slightly scabby and divided in two lots, one of which was treated two hours in a solution of 2 ounces to 16 gallons of water, and the other not. A portion of the untreated seed was planted, adjoining on each side of the treated. All was fertilized and cultivated the same. The soil had not grown potatoes for four years

The untreated seed came up before the treated and the tops appeared more vigorous during the whole season and obtained a fourth greater growth, and the weight of tubers was much more. All the potatoes were about equally scabby.

CONCLUSIONS.

1. That the germs of potato scab will retain their vitality in the soil for at least four years, as shown.

That if the germs are in the soil the treatment of the tubers with corrosive sublimate will not prevent the disease, and is apparently of no advantage.

That corrosive sublimate has a poisonous effect upon potato plants, depressing their vigor and lessening the yield, when the tubers are treated for two hours. (Our observations agree with those of Professor Taft, who says (Mich. Expt. Sta. Bull. No. 108) that treatment for longer than one and a half hours lessens the amount of scab but reduces the yield.

The only advantage then in the use of corrosive sublimate solution is when suspicious seed is to be planted upon uncontaminated soil.

FORMULA.

Dissolve two ounces of corrosive sublimate in two gallons of hot water and then add fourteen gallons more before using. *Remember that corrosive sublimate will corrode any metal vessel and a wooden receptacle should be used.*

Soak the seed in this solution for one and a half hours, dry, and it is ready to plant.

ENTOMOLOGY.

THE SNOW FLEA.

Achorutes nivicola, Fitch.

ORDER THYSANURA: FAM. PODURIDÆ.

Specimens of the above insect were received from B. Walker McKeen June 13, 1894.

This is the *blue black* insect found in such great numbers upon snow on warm winter days, and also at various seasons upon the surface of pools. They often congregate by the thousands upon tree trunks near the base. Those sent by Mr. McKeen were found near the base of an elm tree. These insects *hybernate* in grass about the base of trees and elsewhere, and about the bark of trees. On warm days in winter they come out. The name *Snow Flea* is usually applied to the above species though we have found four other species at Orono during the winter months upon snow. These and related insects are known by the name of *spring tails* because by means of a forked appendage attached to the abdomen they are able to execute leaps. The color is blue black or dark lead color, and the size from one-tenth to one-fifteenth of an inch.

THE SILVER FISH.

Lepisma sacharina, L.

ORDER THYSANURA: FAM. LEPISMIDÆ.

We received the following letter from Mrs. Johnson, accomnied by specimens which proved to be the above species.

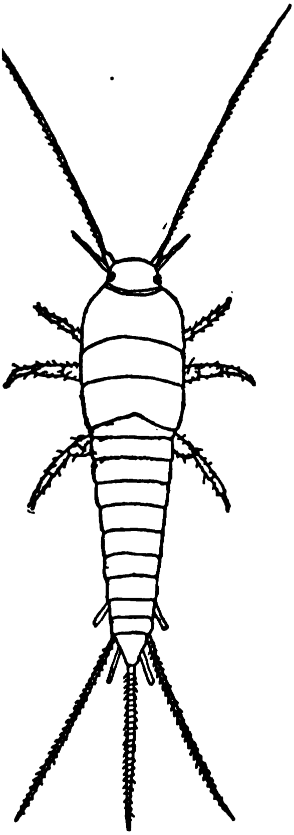


FIG. 5.

GORHAM, Me., Aug. 24, 1894.

F. L. HARVEY.

Dear Sir:—I have sent you three specimens of a bug (?) that has been troubling me this year. Some time in May a beetle, similar in shape to the illustration of the carpet beetle in this week's Lewiston Journal, appeared in the dish closets and on food when it was left exposed. In color it was a silvery gray. It was about a third of an inch in length. About the first of June they disappeared but soon after came in the form of the specimens which I have sent you. These are in everything — dishes, food, clothes, shoes, etc., but I have failed to find any real mischief which they have done.

Please write me what they are.

The buffalo bug is in at least one house in Gorham.

Yours truly,

ROSE C. JOHNSON.

The species of beetle spoken of was probably the common Meat Beetle, *Dermestes lardarius*.

This species may be recognized by the accompanying cut. The nsect is of a uniformly dull silvery color, excepting the feet and ntennæ, which are pale yellow. The size is about one-third of an nch. Mrs. Johnson has given the habits correctly. "They are in every thing." They are capable of doing considerable damage in ibraries and wardrobes, by eating the paste from books, and holes in fabrics. They are very active. As these insects are fond of starchy or sugary substances, they could be destroyed by poisoned sweets.

This same species has also been reported from Brewer, Me.

THE RING-BANDED SOLDIER-BUG.

Perillus circumcinctus, Stäl.

ORDER HEMIPTERA. FAMILY SCUTELLERIDÆ.

We received through Mr. McKeen the following letter accompanied by a specimen of the above well-known parasite upon potato beetles:

BEAN'S CORNER, ME., August 6, 1894.

HON. B. W. MCKEEN, Augusta, Me.:

SIR—I send you herewith a bug that seems to like to stick his proboscis into the larvæ of the potato beetle and lie back and enjoy life as long as there is anything left in the larvæ. I presume you are acquainted with him, but he is a stranger to me. They do not seem to be numerous at present. Perhaps you would give his life history in one of your bulletins.

Yours resp'y,

GUSTAVE PEASE.

This is the first time this insect has been reported to the Station, and as we have not observed it in the State, it is desirable that it be known and protected as a friend to the potato grower. It is a beautiful insect and is sure to attract attention. It may be known by the following description.

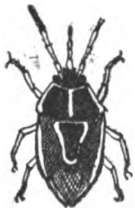


FIG. 6.
(Original.)

Length about one-half inch, width about one-fifth inch. Polished dark brown marked with cream colored bands as shown in the figure. The thorax and scutellum are coarsely punctured.

Head brown above and yellow beneath, mouth parts brown, antennæ five jointed, darker toward the ends, eyes black and prominent, proboscis four jointed, the terminal two black and also the base of the other two on the *under* side.

Thorax arched, polished brown, darker toward the head, bordered above on the sides and in front by a cream colored band which also extends down the middle of the thorax. The *pro thorax*, below, narrowly bordered with cream color and a narrow line of the same color down the middle mesathorax below, with a narrow yellow curved line in front of the second legs and down the center.

Scutellum bordered by a cream colored band.

Wings.—The hard portion bordered laterally by a cream colored band.

Abdomen bordered by a yellow brown band and down the center below a row of four blotches of the same color. The general color below, brown, legs brown, the tarse nearly black. The tibia on all the legs encircled in the middle by a band of yellow.

The mature insect enlarged about one-half is shown in Fig. 6.

THE ELM TREE BARK LOUSE.

Lecanium Caryœ, Fitch, var. *Canadense*, n. var.

ORDER HEMIPTERA: FAMILY COCCIDÆ.

Extract from a paper, by I. D. A. Cockerell, about to be published in the "Canadian Entomologist:"

Scale smooth, shiny, red-brown, convex, malleate but not or hardly plicate. Length 4, breadth 3, height 2 m m., varying to length 5, breadth 4, height 3 m m. (Some Maine specimens 6 m m. long.) Removed from the twigs, the scales leave an oval white mark. (Nappan scales are paler and more yellowish, also somewhat smaller. Posterior incision perhaps a little longer; scales also rather more tending to be plicate.) Male scale ordinary, rugulose.

With 6 jointed antennæ, formula 326154. 3 considerably larger than the remaining joints put together, 1 with 2 hairs; 2 with 2 hairs at its end, one especially long; 3 with 2 hairs near its end, last joint with several hairs, one especially long. (Nappan antennæ practically the same, but 1 larger; 4 and 5 each show a hair, 6 hardly so long, formula 3(126)54. Maine antennæ show one long hair at end of 3, 2 with 1 very long hair, 2 a little longer than 4, 4 a very little longer than 5, 6 a little longer than 2; formula 36245.) Derm obscurely tessellated, with large gland-pits. (In Maine specimens gland pits frequently in pairs.)

Femur not much larger than tibia. Tarsus hardly 1-3 shorter than tibia; distinctly swollen at base. Claw rather stout, curved at its tip like a falcon's beak. Digitules of tarsus apparently wanting (deciduous?) Digitules of claw large and distinct, extending well beyond tip of claw, stem moderately stout, knot large and oval. A bristle on end of coxa, one on end of femur and one on end of tibia. (Nappan scales show legs much the same, but femur proportionately longer, tarsus only a little swollen at base; tarsal digitules well developed, long, ordinary; digitules of claw short, not extending to end of claw; claw stout, nearly straight not hooked. Maine examples show coka stout, broader at base than its length, with a hair at its tip; trochanter with a long hair; femur longer than tibia, tarsus about 1·3 shorter than tibia; digitules all filiform.)

Eggs.—(Maine specimens) very pale pinkish.

Hab.—The types are from Stittsville, about 20 miles from Ottawa, Ontario, on *Ulmus racemosa*, sent by Mr. Fletcher. Other specimens are from Nappan, Nova Scotia, on elm (Fletcher) and Orono, Maine, on elm (Harvey). Prof. F. L. Harvey states that it is very abundant at Orono; he has known it for 8 years, and it is increasing. The branches are often almost covered with them.

The Stittsville examples are affected by a coccinellid and by an Encyrtid parasite, perhaps a *Chiloneuras*.

The species is quite different from the European *Lecanium vlmi*, and is doubtless a native of this country. It illustrates well the extreme difficulty of dealing with the American species of *Lecanium;* which have,perhaps, not succeeded in reaching a condition of specific equilibrium since the new developments, which doubtless followed the termination of the glacial epoch. It will be seen from the above, that the characters given are quite variable, unless we are dealing with three species instead of one—a view which I cannot for a moment entertain. While thus convinced that all these elm forms are strictly one thing, I have a very lively conviction that *L.ribis*, Fitch, is different—a conviction which I feel sure would be shared by any one who had seen quantities of both—yet it is difficult to point out the precise nature of the difference, apart from the smaller size of *ribis*. Two species of Fitch, *L. Cynosbati* and *L. Caryœ* have been re-described by Signoret, who shows that they have 6-jointed antennæ like *ribis* and *Canadense*. I have not seen authentic examples of either, but the description of *L. Caryœ* agrees so nearly with our elm species that I place the latter under it as a variety."

The above description refers to the bark-louse found so abundantly upon the elms in Maine and referred to in the introduction as The Elm Tree Bark-louse, which Mr. Cockerell describes as a *new variety*.

THE GOOSEBERRY PLANT-LOUSE.

Myzus ribis, L

ORDER HEMIPTERA: FAMILY APHIDÆ.

We have received from Mr. Delano Moore and other parties during the last three years, specimens of gooseberry twigs, in which the leaves at the end of the branches had been killed, resulting in the development of several short sub-terminal shoots, making a terminal dense cluster of short branches and small leaves. Careful examination of several specimens did not reveal any insect at work, nor could we find any evidence that the main shoot had been infested by either insect or fungous parasites. There were present in several specimens the moult skins of a species of aphis or plant-louse, which we presumed had to do with the injury.

The species mentioned above is known to infest currant and gooseberry bushes, causing the leaves to curl and blister, and though we were not able to identify the species from the molt skins, suspect it is responsible for the injuries.

To secure the insects for examination it will be necessary to search for them earlier in the season. The attention of those who have been troubled by these *terminal growths* on gooseberry bushes, is called to the matter. We would like to receive specimens earlier in the season. When the terminal leaves begin to show injury.

THE OBLIQUE-BANDED LEAF-ROLLER.

Cacœcia rosaceana, (Harris.)

ORDER LEPIDOPTERA: FAMILY TORTRICIDÆ.

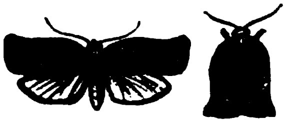


FIG. 7.
The moth of the oblique-banded, leaf-roller.

On June 11, 1894, we received specimens of the larvæ of this insect from Mr. Charles S. Pope, Manchester, Me. Accompanying the specimens were currant twigs showing the work of this insect. To make sure of the species we allowed the larvæ to transform.

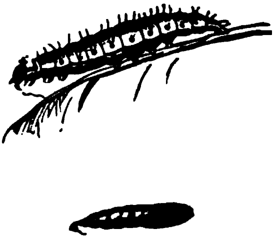


FIG 8.
Larva and pupa of the oblique-banded leaf-roller.

This insect is a general feeder having been found upon many species of the ROSE and SAXIFRAGE families and probably feeds upon the leaves of the plants of other families. The name leaf-roller applied to this insect is derived from the habit the larvæ have of rolling the leaves of the food plant into hollow cylinders in which they live.

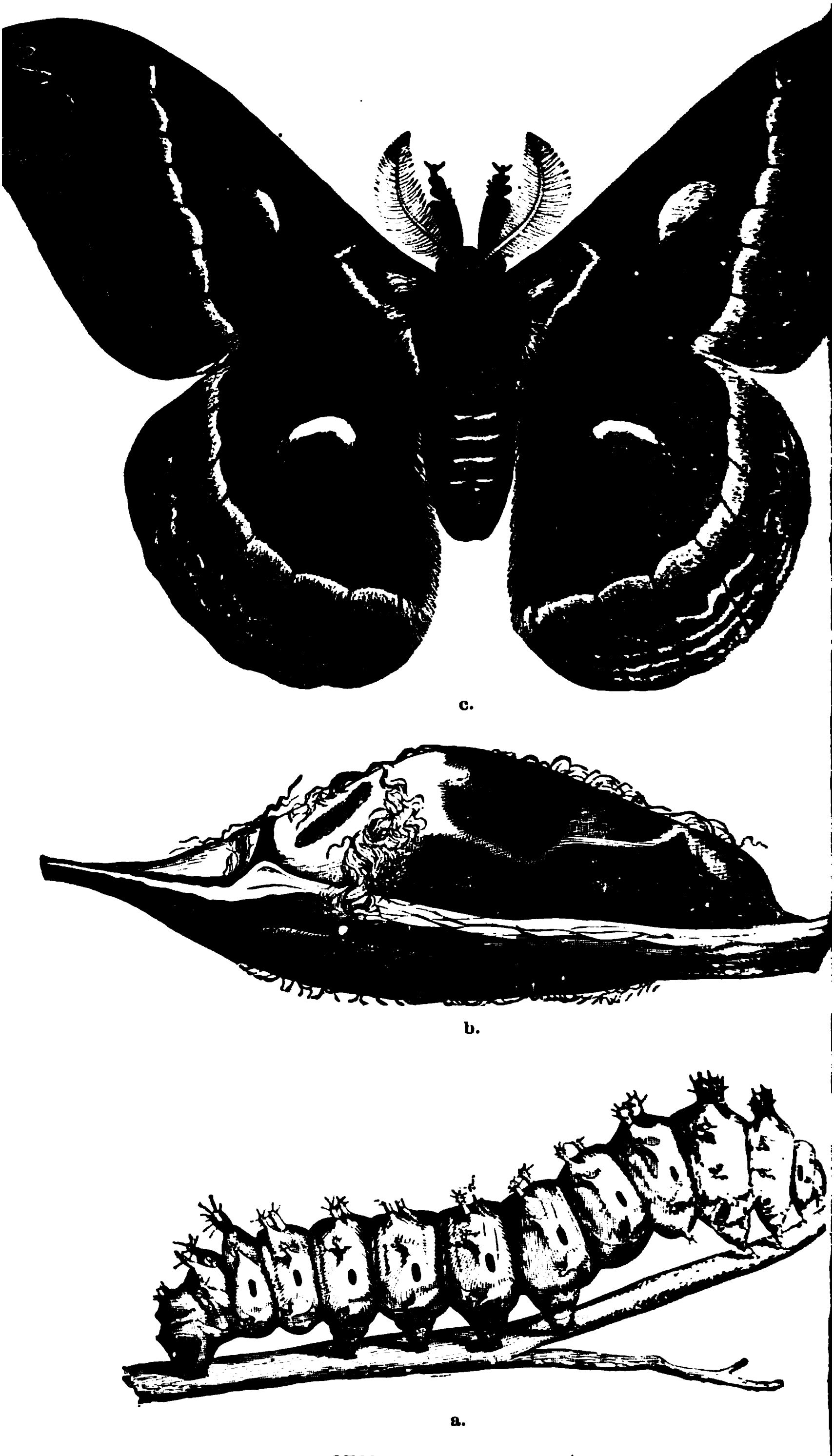
DESCRIPTION.

This insect may be known in the *larval* form by the pale green, yellowish green or reddish brown color with the head and top of first segment brown. There is a dark green stripe along the back and a few smooth dots from each segment bearing a short fine hair. The cut, Fig. 8 shows the larvæ somewhat enlarged. When full fed the larvæ changes to a chrysalis within the tube in which it lived.

The chrysalis is shown, Fig. 8. From the chrysalis the bell shaped moth shown in Fig. 7 comes forth.

REMEDIES.

The clusters of rolled leaves should be pinched and the larvæ killed if within reach. Spraying with pyrethnum or Paris green would kill them.



CECROPIA EMPEROR MOTH.

Platysamia Cecropia (Linn).

FIG. 9. (a) Larvæ. (b) Cocoon. (c) Moth.

THE CECROPIA EMPEROR MOTH.

Platysamia Cecropia, (Linn.)

ORD. LEPIDOPTERA: Fam. BOMBYCIDÆ.

Every season for the last eight we have received either larvæ cocoons or moths of the above species accompanied by letters of inquiry. We have concluded to publish cuts of all the stages of this conspicuous insect. Those who wish a description will find it in Expt. Station Rept., 1890, p 121. The insect is distributed throughout the State as specimens have been received from every section.

Fig. 9 a, represents the larvæ full size; Fig. b, the cocoon full size; Fig. 9 c, the full sized moth.

THE CHINCH BUG.

Blissus leucopterus, Say.

ORDER HEMIPTERA: FAMILY LYGÆIDÆ.

In company with Hon. B. Walker McKeen we spent two days last September in the vicinity of Fryeburg examining the area infected by chinch bugs.

HISTORY.

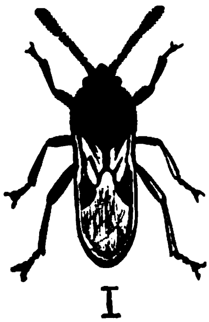


FIG. 13. CHINCH BUG. The short line below shows natural length.

By interrogating some of the oldest inhabitants we learned that this pest has done more or less damage in the intervale lands about Fryeburg for at least twenty-five years. It does not affect the area infested uniformly, but occurs in patches, often skipping entire farms. Nor is the infested area the same from year to year. Farms infested one season may become exempt the next and those not infested one season infested the next. Then there are seasons favorable for the bugs when the damage done is greater over the entire area and then seasons of minimum damage. The insects do

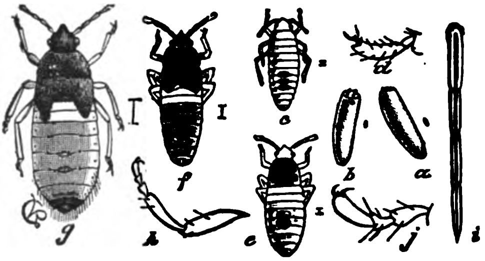


FIG. 14. CHINCH BUG, LARVA, PUPA AND EGG.

a and *b*, eggs; *c*, young larva; *d*, tarsus of same; *e*, larva after first molt; *f*, larva after second molt; *g*, pupa; *h*, leg; *i*, beak or tubular mouth; *j*, tarsus of mature bug.

not occur in such hordes as they do in the West even in the worst infested farms. In small fields there were many isolated patches of a few feet or rods in extent. Only in one or two places did we find large continuous areas infested. They were the worst in the low, sandy lands, but were found in some places on the uplands, notably on the farm of Charles Chandler, Fryeburg Center.

RECORD OF OBSERVATIONS.

We began our observations at the farm of Mr. B. B. Woodward, N. H., where we found the bugs in abundance, in small patches in grass lands. This farm is the *southern limit* of the infested area so far as we know, though they may be found farther south. Proceeding north we visited the farms of E. W. Burbank and Henry Andrews, where the insects were working in patches. The grass was dead and dry in one of these fields and the bugs were abundant on the edges of the dead patches extending their depredations. We burned over one of these patches to see what would be the effect on the bugs, and found that only a few of them were killed. They work so deep about the roots of the grass that the heat does not reach them.

At the farm of Charles Chandler, Fryeburg Centre, they were working upon the uplands and at George A. Charles' farm they had destroyed the whole field. At the farm of Wilson Webb they had been working in a field of corn. They had destroyed the adjoining grass land and injured a few rows of corn at the edge of the field. We found a large number of dead bugs covered with mold in the sheaths of the leaves but was not able to decide that the fungus was the cause of their death.

The fungus proved to be a common mold and originated, probably, in the juices exuded where the leaves were eaten and finally extended to the dead insects. So far as we could learn but little damage is ever done to corn by this pest. They were doing much damage on

John Hastings' land near the above corn field. At Dexter Walker's there was a fine field of corn adjoining grassl and badly infested. It would seem that they do not leave the grass for corn as long as the food supply holds out. Mr. A. K. Price had already plowed his grass land to destroy the insect. If the bugs are bad the land would have to be reseeded and by plowing early and deep, the bugs would be buried and destroyed. We called on Mr. Simeon Charles from whom we originally received specimens and found his fields infested. The most northern place of their occurrence known to us positively is the farm of Albion Wyman, North Fryeburg, but we have good reasons for believing they occur about Bethel, twenty-five miles further north. They occur throughout East Fryeburg and also in Bridgton, the township on the east. We stopped at several other places than those mentioned and noticed the work of the bugs in several fields as we drove by. The above places mentioned will outline the infested area, which would appear to be about seven miles long by about two wide. Those who wish a description of this insect will find an account of it in Experiment Station Report, 1892, page 124, besides other information historical and remedial.

REMEDIES.

In Illinois and other western states where the chinch bug occurs in great numbers, over large areas, attempts have been made to destroy them by infecting with fungi, the principal one being (White Murcardine, *Sporotrichum globuliferum*, Speg.)

The results of these experiments have been so uncertain that we regard any attempt to control or destroy the pest by this method in Maine as time wasted. The fact that the insect works in isolated patches makes the problem in Maine a different and difficult one. In the West the bugs affect the wheat and small grain early in the season and as soon as this is harvested they migrate in hordes to the corn fields. In Maine small grain is not grown to any extent. Before haying the bugs live on the grass leaves and after haying do not migrate but transfer their depredations to the roots of the grass, killing everything as they go, remaining in the grass land as long as food supplies hold out. They are particularly destructive to timothy grass lands. Chinch bugs are very sensitive to wet weather and are never so bad in damp, rainy seasons.

The following suggestions may prove helpful in checking the pest:

1. Watch the fields after haying and if the bugs begin to work in patches as shown by dead places in the grass then *at once* spray the living grass for a distance of ten feet where the bugs are feeding along the edges of the patches with kerosene emulsion.

2. Should the bugs appear over the whole or the greater part of a field there is no hope of saving it but in order to destroy the bugs the land should be plowed deep and rolled as soon as possible after haying.

3. So far as possible it would be well to burn grass lands. The burning destroys some and the remainder are more exposed during the winter to injury. After haying or early in the fall all rubbish about the fences and border of the fields should be raked in heaps. The bugs will seek the rubbish for winter quarters. The rubbish should be burned late in the fall or very early in the spring.

4. The chinch bug feeds only on plants of the grass family. Fields badly infested could be planted to clover, buckwheat, beans, potatoes, turnips, etc., and the bugs starved. Frequent rotation of grass with the above crops would tend to keep them in check. If by concerted action all of the infested field in the area could be turned after haying the same season, it would go far toward destroying the pest. Whatever method is adopted there should be concerted action. The chinch bug does not travel very much and the application of remedial measures and its suppression becomes largely an individual matter. No farmer can lay the blame for its presence and depredations upon the inactivity of a shiftless neighbor.

THE BUFFALO CARPET BEETLE.

Anthrenus Scrophulariæ, L.

ORDER COLEOPTERA: FAMILY DERMESTIDÆ.

During the last few years we have received letters from the western and southwestern part of Maine regarding an insect doing much damage to carpets and woolen clothing. Several times these letters have been accompanied by specimens, leaving no doubt that the pest is the insect whose name appears at the head of this article. This insect is called the buffalo bug in Maine, but in other localities is variously known as the carpet beetle, buffalo carpet beetle and buffalo moth.

Perhaps the many common names given to an insect is of little importance, but they are confusing and are apt to annoy the systematist who insists upon exact use of terms. To the practical man the important points are identification; a knowledge of how to cope with it, if injurious, and how to utilize its good qualities if beneficial.

This insect belongs to the order Coleoptera, which embraces the hard-winged insects called beetles. To call it a "bug," which is the name belonging to insects like the squash bug (*Hemiptera)*, or to call it a "moth," which is a term restricted to a portion of the scaled winged insects (*Lepidoptera*) would be entomologically incorrect. This insect is properly called a beetle, and in allusion to the shaggy appearance of the larvæ, and the fact that it injures carpets the name Buffalo Carpet Beetle would be appropriate.

HISTORY AND DISTRIBUTION.

The insect was first described by Linnæus in 1758. On account of its feeding upon plants of the genus *Scrophularia* he named it *Anthrenus Scrophulariæ.* It is now known, however, to feed upon a wide range of plants including fruit trees, tulips and roses. Though a vegetable feeder by nature it readily changed its dietary and in Europe as early as 1779 was known to frequent houses and to destroy collections of insects and plants, clothes, furs, leather and victuals. It was known in Europe in 1855 as The Common Flower Beetle. It is an interesting example of the power some insects have of adapting themselves to new surroundings and new food.

Though known in Europe for over a hundred years, it was not detected in America until 1850, when Dr. Le Conte found a variety of it on flowers in California. It was, according to Le Conte, probably imported during the Spanish occupancy of that country. It was on the Pacific coast that it was rechristened "the buffalo bug."

In the Eastern states they were first discovered near Buffalo, New York, in 1872, and a little later in Massachusetts. Dr. Hagen investigated the matter in Boston, and found that the infested carpets came largely from a single large carpet house, and he inferred that the pest was introduced in imported carpets

Since its introduction it has spread more or less, and is now known in all of the New England states, as far west as Illinois and as far south as Washington. In Europe it has not figured as a carpet beetle, as carpets are little used, and rugs more common. The insect is retiring in his habits and does not thrive in rugs, which are frequently taken up and shaken. Perhaps in the growing custom in this country of using rugs, housekeepers will find a means of controlling this insect, which is now in many localities the greatest household pest.

We have but little data regarding their introduction or even distribution or prevalence in Maine. Nearly eight years ago we received a single complaint, and presume they have been in the State for years. They probably came in from the way of Massachusetts through carpets purchased in Boston. We have had complaints from Bangor and Belfast, the eastern part of the State. This article, we hope, will call attention to the pest and bring it to light and help determine its distribution. We will be pleased to examine any carpet insects sent us, *but be very careful if specimens are sent to put them in a tight tin or metal box, which should be inclosed in an outer wooden or pasteboard box.* We would also like to have those who know positively that the buffalo carpet beetle is in their neighborhood send a postal card to that effect. There are several other small beetles that destroy carpets, also carpet moths, and besides other harmless small beetles are often found in houses, and are liable to be mistaken for this pest. The only safe way is to have the insect identified by an entomologist. Prof. Lintner gives a case where a beneficial beetle (a lady bug) was mistaken for the buffalo carpet beetle.

DESCRIPTION.

Eggs—We find no description of the eggs in any work at hand and have no specimens to examine. They must be very small, and the belief is that they are laid by the female on the carpet or clothing attacked and not in the cracks of the floor, as some suppose.

Larva—The full grown larva is about a quarter of an inch long, dark brown and clothed with stiff brown hairs which are longer on the sides than on the back and still longer on the extremities. These hairs form tufts at the sides and extremeties. The posterior end bears three tufts of long hairs and the head a bunch of shorter ones. Fig. A shows the back view of the larva much enlarged, the real size being shown by the hair line at the right. Fig. B shows the under side enlarged.

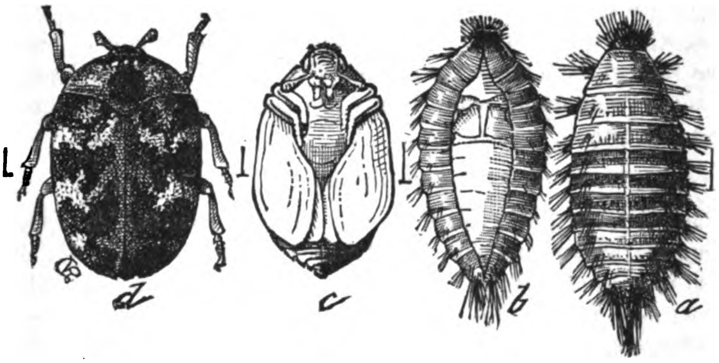


FIG. 10.

Pupa.—It is shown in Fig. c, enlarged. The real size being shown by the hair line at the left. It is brown in color and is the quiescent stage in the life history of the insect between the larva and the perfect beetle. The larva moults six times at least in coming to maturity. and finally the pupa is formed in the last larval skin, and after a time this larval skin splits open along the back, revealing the pupa from which later the full grown beetle emerges. The cast-off larval skins are usually found in abundance, giving the impression of a greater number of the pest than really exists. The larva are very tenacious of life and will go a long time without food. We kept some one time in a tin box for nearly a month without food, and they were still alive. When deprived of food the growth is slow and the moults more numerous. It is the larva that does the mischief.

Perfect Insect.—A beetle three-sixteenths of an inch long and nearly as broad. The broadly elipical outline is shown in Fig. a, which is enlarged, the real size of the beetle being shown by the hair line on the left. The beetle is black and white and scarlet. The ground color is black with three irregular white bands across the wing covers [elytra] and a scarlet stripe down the middle of the back widening at three points to meet the three irregular white bands. The antennæ are black, eleven jointed and bearing a three jointed club at the end. The head is black marked about the eyes and mouth by a few orange red scales. Under side of the body black with red and white scales. The color is variable. Sometimes the red band down the middle of the back is white and sometimes the two anterior white bands are confluent, forming a broad band of white.

LIFE HISTORY.

The beetles begin to emerge in the fall and continue to appear during the winter and spring. There is believed to be but one brood in a year, though the time of emergence of the beetles would depend upon the conditions of heat and cold and food supply in the houses and rooms frequented. In heated houses and rooms they would transform more rapidly, while scarcity of food has been shown to prolong the life of the larva and increase the number of moults. When on the wing they may be found often on window panes and in the fall out of doors upon plants of the sunflower and figwort families. Though Professor Riley thinks they lay their eggs in the house before they leave it we see no good reason why they may not, as they do in Europe, lay their eggs and maintain themselves out of doors. The beetles soon pair after they merge and the eggs are supposed to be laid upon the clothing and carpets effected. The eggs soon hatch, if the temperature is favorable, and the young larvæ attack the exposed edges of the carpet, clothing, etc , often following a single thread or stripe in a carpet for a long distance. When mature, in the fall, having moulted at least six times, they seek cracks in the floor or other places of concealment and transform to the pupa state within the last larval skin. The pupæ finally ruptures along the back and the beetles emerge, completing the round of life.

REMEDIES.

Difficulties.—This is a very difficult insect to exterminate, the despair of the shiftless housekeeper and nearly a match for the fastidious, uncomfortable ones who are ever upon the alert for the last speck of dirt and first indications of insect pests.

It does not readily yield to the ordinary insecticides like camphor, cedar oil, pepper, tobacco, turpentine, carbolic acid and pyrethrum, etc. Benzine when properly applied has been found to be the most convenient and best remedy. Even with this the most energetic and persistent measures are necessary. The aim should be extermination of the pest in the house, as a few overlooked would multiply rapidly and increase the difficulty.

Precautions.—[*a*] There are quite a number of carpet insects, beetles and moths. The first step should be the positive determination of the pest doing damage Learn to recognize the larvæ, pupæ and beetles and then wage a ceaseless war against them in every stage of their life history. If you do not know the insect, or can not decide from the description given above that it is the buffalo carpet beetle, then put some specimens in a tight metal box and send them to the entomologist of the experiment station at Orono, Me., and he will cheerfully name them.

[*b*] Remember that benzine is an inflamable liquid. Do not bring a light near it. Do not apply benzine to a room in the evening when lights are burning or enter a room with a light when it is filled with the vapor. It is well enough to keep a room closed while the benzine is being applied so it will not evaporate too rapidly. The strength of the vapor favors the destruction of the larvæ and beetles.

Having decided that you have the buffalo carpet beetle to grapple with, then apply the following remedies.

PREPARATION OF ROOM.

As the larvæ crawl into cracks in the floor and under the baseboards to transform, precautions should be taken to fill, so far as possible, these hiding places.

a. Fill the cracks in the floor and the crevices at the bottom of the baseboards carefully with a moderately thick mixture of plaster of paris and water. This will set hard and prevent their entrance.

b. Should the use of plaster of paris be inconvenient or undesirable, then, by means of a hand-atomizer charged with benzine, puff the liquid thoroughly into all the floor cracks and crevices about the baseboards. It would be well to leave the carpets off a few days and make the second application of benzine before putting them down.

c. When cleaning house it is best to take up all the carpets at once, and thoroughly clean all the rooms before putting any of the carpets back. The common way of cleaning one room at a time and returning the carpet at once would give the pest a chance to fly or crawl from one room to another while the work is going on.

d. It has been recommended to put a strip of tarred roofing paper around the border of the room before the carpet is laid. This would no doubt help to repel the attacks of the beetles and would be desirable if the odor was not objectionable. The odor of napthaline, gasoline and bisulphide of carbon and kerosene make the use of these efficient remedies undesirable in the house. A tight box filled with the vapor of bi-sulphide of carbon from above is used by naturalists to disinfect museum specimens and it could be used to disinfect carpets out of doors. It is very volatile and highly inflammable. The vapor is very heavy, being two and a half times as heavy as air and settles rapidly.

PREPARATION AND CARE OF CARPETS.

a. In Europe this beetle is not known as a carpet pest because the use of carpets is not common. Rugs which can be taken up and frequently shaken are more in use than in this country. In a badly infected house it would be well, if possible, to discard the use of carpets for a time and use rugs, taking them up frequently and shaking them. A more extreme measure would be to discard carpets and rugs for the summer season. If carpets are used they should be taken up at least twice a year, thoroughly beaten and lightly sprayed with benzine and left out of doors until the benzine evaporates. Leaving carpets down the whole season and then cleaning them carelessly gives the pest fine chances to increase unmolested.

b. As the larvæ attack the exposed edges of carpets, they are usually found around the border of the room.

If the depredations of the insect are noticed between the times of house cleaning and it is not convenient to take up the carpet

then take a damp, folded sheet or cloth and spread it smoothly over the infested spot and iron it thoroughly with a hot iron. Allow the iron to remain long enough to generate steam sufficient to penetrate the carpet and destroy the insects. If thought desirable the whole room could be so treated but the benzine method would prove less laborious. Some leave the carpet untacked and turn the edges back occasionally and examine them carefully.

c. When you buy a new carpet from a local dealer in the infested district, or import one from the larger cities, it would be well to examine it carefully and spray it with benzine before putting down. There is no doubt that the pest was introduced in carpets purchased in the city or cities where the pest has been found in the large carpet houses.

d. The custom of sending carpets to the cleaner has its danger as a cleaning house would be very apt to harbor the pest. When returned, carpets should be sprayed with benzine before putting them down.

e. Carpet cleaners in the infested district could easily arrange to give all carpets a dry hot air or steam bath of from 160° to 200° and thus thoroughly disinfect them after they are cleaned.

f. Carpets to be stored for the summer should be thoroughly beaten, disinfected by spraying with benzine and put into a tight box, the cracks of which have been previously sprayed with benzine. A box can be made tight by pasting paper over the cracks. Some line boxes with tarred paper and sprinkle napthaline crystals (*crysta alba*) in the fabric. This is better than camphor gum and is a good expellant, is cheap, and leaves no stains or offensive odors behind.

Care of Clothing.—Clothing to be stored should be treated as recommended for carpets. Drawers or boxes in which infested clothing has been stored should be thoroughly sprayed with benzine.

Furniture.—Cloth covered furniture should be thoroughly steamed or sprayed with benzine.

If the methods advocated above are carefully applied for two or three seasons, even so difficult a pest to exterminate as *Anthrenus Scrophulariæ* will be compelled to yield.

THE OAK-BARK WEEVIL.

Magdalis olyra (Herbst).

ORDER COLEOPTERA: FAMILY CURCULIONIDÆ.

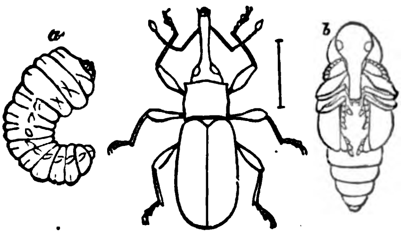


FIG. 11. Larva, pupa and beetle of Magdalis olyra.

Specimens of the above insect were received from Mr. B. Walker McKeen and sent him by Mr. Delano Moore of Presque Isle. They were said to be feeding on the leaves of elm trees in that region. This being a new habit for this species we wrote Mr. Moore asking him to send more of the insect and some of the leaves upon which it was feeding. Here we give a cut of one of the leaves showing the nature of the work. Mr. Moore writes that this species was also very abundant upon hazel bushes in June, destroying the leaves. We sent some of the beetles to Dr. Horn, who pronounced them the above species.

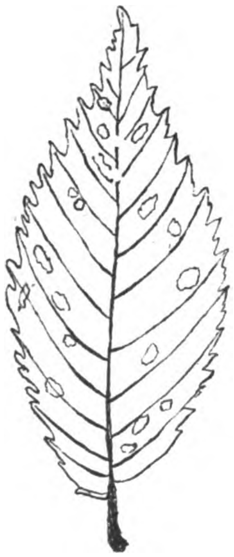


FIG. 12. Elm leaf eaten by Magdalis olyra (original).

Dr. Packard says [in Forest Insects, p. 80] that this species infests *oak trees*, the larvæ living under the bark. We do not know whether the larvæ attack elm trees or not, but possibly this is so, as the perfect beetle feeds on the leaves. This species can be recognized by the cut and following description: Color dark reddish brown to nearly black, clothed with short lighter colored hairs. The base and tips of femora and rest of the legs including the antennæ pitchy reddish. Length one-fourth to one-third of an inch.

We know no remedy. Should it confine its attacks largely to hazel bushes it would be more beneficial than otherwise.

THE FALL CANKER WORM.

Anisopteryx pometaria, Harris.

When we first began to observe this insect in 1887 it was not very abundant about Orono and did no material injury. It gradually increased from year to year and in 1893 had become so abundant as to do much damage to orchards and shade trees. The foliage of trees on the college campus and in Orono were so badly eaten that it was feared they would die. For some unknown reason, probably from the increase of parasites that prey upon this species, it almost entirely disappeared during 1894 and has given no trouble whatever about Orono in the summer of 1895. The insects seem to be migrating or passing over the State like a slowly moving wave from the north toward the south. Its depredations have gradually spread down the Penobscot valley. In 1893 they were very abundant in Arnold and Prospect and this season (1895) they are doing so much damage to the shade trees in Thomaston that a town meeting will be called to consider the means necessary to check them. Mr. E. P. George, President Thomaston Improvement Company, writes that "canker worms appeared upon a few of our fruit trees about four years ago. They have increased in numbers each year and gradually spread to the elms until this year fully three-fourths of the eight or nine hundred elms and fruit trees in the village were completely infested and deprived of their foliage by the end of June." The trees about Orono were not killed. They no doubt suffered a severe shock and the growth for a season or two was greatly checked but they seem to have regained their usual vigor. It took the worms about five years to reach the period of greatest numbers at Orono and if they have the same experience at Thomaston with them they will not be so abundant next season. It is well known to entomologists that insects have gradual periods of increase and then suddenly decline. We had a very good example of this in Maine in the case of the Forest Tent Caterpillar, which is fully explained by rapid increase of parasites, (see Station Report 1890, page 138.)

Report of Veterinarian.

F. L. RUSSELL.

TUBERCULIN AS A DIAGNOSTIC AGENT.

No apology need be offered for a report relating to bovine tuberculosis. The importance of the subject is excuse enough.

Those who are impatient at the amount of attention the subject is receiving from all quarters need to realize its importance more fully than they do. It is doubtless possible to take extreme ground in advocating the importance of tuberculosis from a sanitary and economic standpoint, but the general public is so far from realizing the true importance of the matter that there is need of even these extremists. There is no safety in ignorance or indifference. Safety consists in recognizing existing dangers, and adopting the most efficient means of combating them. The world moves; and this is true even in relation to medical science and it has been especially true during the last ten years. Greater advance has been made in our knowledge of the causes of disease during the past ten years than in the fifty years preceding. And with the increased knowledge of the causes has naturally come a corresponding knowledge of the means of preventing and of curing disease. The magnitude of this progress, and its far reaching results in prolonging life and preserving health it is yet difficult to realize.

The most progressive and enlightened can hardly comprehend it, and it is in no way strange that the public that is to be directly benefited is somewhat slow to accept facts that are new and not well understood. Knowledge must always be in advance of practice, and there are never lacking those extremely conservative individuals who cling to the old until nearly everybody else has acknowledged the value of the new. These individuals have their place, no doubt, and act in some measure as a balance wheel, but progress is made in spite of them and not with their help. There are those even at the present time, who are decrying vaccination against small pox and insisting that it does more harm than good but vaccination is almost universally practiced in civilized countries in spite of them, and thousands of lives are saved by it.

Tuberculosis is by far the greatest scourge among diseases that has cursed this earth through all the past centuries as far back as history extends. As the effects of light, air, food and exercise upon the health of the individual have come to be realized many lives have been saved, and those sick, even with consumption, have been restored to health. But it was with the discovery in 1884 of the tubercle bacillus and the establishment of the fact that it was the active agent in producing all forms of tuberculosis that the foundation was laid for substantial progress in overcoming this disease. Whether it will ever be possible to cure a large proportion of cases is still in doubt, but it has become entirely evident that it is possible to prevent its attack. The deep seated convictions of centuries are not easily changed, and necessary means cannot immediately be put in operation. There has to be time for the popular intelligence to appreciate the need and the advantage to be gained. Considering that only a little more than ten years have elapsed since the important discovery I have mentioned, was made, great progress has already been made. Houses in which consumptives have lived are disinfected, some degree of isolation of tuberculous patients is attempted, and the food supply is watched that it may not carry disease. That these precautions are everywhere or even generally adopted, is not true, but they mark a decided advance and give promise of the time when, with a more general knowledge of the means to be used and greater appreciation of the advantage to be gained we shall have laws, well sustained by public sentiment, that will successfully control the spread of tuberculosis among man and beasts. When this time shall come many years will be added to the average duration of human life, and it would seem that the way is prepared for bringing about this desired end almost within the next generation. The time must come, and should come soon, when every case of tuberculosis shall be attributed to gross carelessness or almost criminal negligence in not using well recognized and reliable preventive precautions. In this regard we wish to deal with a phase of the subject that has vital relations to public health, and is also vastly important from an economic standpoint. However opinions may differ in regard to the absolute relation between human and bovine tuberculosis it is generally conceded that tuberculosis of cattle affects in some degree the public health, and if it were not for the pecuniary side of the question, there would not be the slightest protest against destroying every case of bovine tuberculosis as soon as it could be discovered by any available means. Some degree of danger to human beings from tuberculous cattle is generally conceded. The whole trouble when it comes to disposing of the three or four per cent of tuberculous cattle in Massachusetts or the one per cent more or less of tuberculous cattle in Maine, hinges on the matter of expense. It is human lives in the balance with property, and where it is my property against some one else's life, the property consideration is apt to outweigh human life. There is a disposition to ignore, or make light of the danger and magnify the loss. What is needed is a more general appreciation of the danger, which is certainly real, if not as extreme as the most radical would claim; and the pecuniary loss from the destruction of a few hundred head of sick and comparatively worthless cattle would have little weight. To entirely eradicate human tuberculosis within any given time is impossible. We can't and don't want to use the necessary means; this will be a work of generations and almost entirely along the line of prevention, and the extermination of bovine tuberculosis would be a long step in that direction. But with the means now at our disposal it is perfectly feasible and when rightly viewed I believe it will be considered highly desirable to free this country of human tuberculosis within ten years. We have simply to destroy the comparatively small number of animals that are now diseased, disinfect the places where they are stabled and institute a system of periodical inspection that need be neither cumbersome nor expensive compared to the great end to be gained. Half way measures which simply attempt to control must prove more expensive in the end and not nearly as satisfactory in the results. I know the claim is made that, if all tuberculous cattle were destroyed, it would be but a little time before there would be just as many: but this does not seem to me reasonable. We know that individuals have cleaned tuberculosis out of their herds and kept it out and what is possible for an individual is possible for a community of individuals. The same system of inspection that will enable us to get rid of tuberculosis in the first place will render it possible to keep rid of it. Besides human consumptives will not always be allowed to spread disease broadcast and with all tuberculous cattle destroyed there would be the chief danger to our herds.

Until within very recent years when there has been any attempt to exterminate bovine tuberculosis there has been an insurmountable difficulty in the impossibility of discovering cases until considerable advance had been made. Diseased cattle might remain in a herd for years and their true condition not even be suspected. Although nearly every state has enacted laws for the purpose of controlling or exterminating bovine tuberculosis no apparent headway has been made. There would seem to be as many tuberculous cattle now as ever. To be sure no serious attempt has been made to thoroughly exterminate the disease in any large territory for it has been a recognized impossibility and it is doubtful if the results from the work done have justified the expense, whether they have or not is certainly open to discussion. The destruction of an animal that has already thoroughly infected her surroundings with disease germs and with only a short natural leave of life remaining may be of doubtful importance. She has probably already done most of the harm she is capable of. With the discovery of tuberculin and its effects upon tuberculous cattle we entered upon a new era. What was before so nearly impossible as to discourage effort becomes comparatively easy and it will be strange if during the next ten years we do not see more advance made in getting rid of bovine tuberculosis by the aid of the diagnostic properties of tuberculin than would have been possible in any length of time if dependence had to be placed on a physical examination. In regard to the value of the tuberculin test in diagnosing tuberculosis there can now be no question. The only wonder now is that there should be any opposition to its use or that dependence should longer be placed in a physical examination. But extreme conservatism or ignorance of the comparative value of the tuberculin test probably accounts for it. It is my purpose in this report to review some of the results obtained by the use of tuberculin as compared with a physical examination. Our own experience in the use of tuberculin covers more than three years. We have held autopsies on thirty-two cows, heifers and bulls that reacted under the test, and, although we claim a fair degree of skill in making a physical diagnosis, there were not over ten of these animals that we would have condemned from a physical examination alone,yet with possibly two exceptions they all exhibited tuberculous lesions. In two cases where it was necessary to hold a very hasty autopsy by lantern light no lesions were found. At the state college of Pennsylvania the college herd was given a physical examination, and tested with tuberculin, by two different parties. Only one case of tuberculosis was found by a physical examination, and four by the tuberculin test. One cow that seemed to be tuberculous from a physical examination proved to be suffering from a slight disorder of an entirely different nature. Since last October cattle taken to the Brighton and Watertown markets have been tested with tuberculin by the veterinarian of the Boston Board of Health and destroyed at the owner's loss when found diseased, so it is safe to assume that only apparently sound cattle have been sent there since that time. During the first six months over one hundred animals were condemned and the autopsies showed that 79 per cent were tuberculous, and of sixty-three beef cattle passed as sound and slaughtered, four were found to be tuberculous. Here we have the tuberculin test applied under the most unfavorable conditions upon cattle just arrived from a long journey and surrounded by all the disturbing influences of an open market, yet the result must be considered very favorable to the tuberculin test as compared with any physical examination.

The biologist of the New Jersey Experiment Station, Professor Julius Nelson, reports that of the forty-three animals of the college herd examined by him, reactions were obtained in twenty-eight cases and at the autopsies twenty-five were evidently diseased. The other three, one cow and two heifers were apparently sound but he says the temperature of these three varied so little from the normal that he was in doubt whether they reacted or not, and he killed them on mere suspicion. This same herd was subjected to a careful physical examination before the tuberculin was used and fifteen animals selected as diseased, three of which proved to be sound. Dr. Austin Peters in an address delivered in Boston recently assumes as a result of his observation that only a quarter or a third of the cases of tuberculosis revealed by means of tuberculin would be discovered by a physical examination. Dr. Laws of Cornell, a very conservative man, says in a bulletin published a little more than a year ago. "When the State aims at a thorough extinction of the disease (tuberculosis) in our herds this test (tuberculin test) cannot be omitted as it is absolutely essential to success," and what he says in regard to the extinction of tuberculosis from a state has equal force when applied to a herd.

In regard to the effect of tuberculin upon healthy cattle, in a recent bulletin Dr. Laws produces testimony based upon his own experiments and those of the United States Bureau of Animal Industry that shows, as far as these experiments go that the injection of a test dose of tuberculin into a healthy cow, even if repeated several times, has no appreciable effect upon the productiveness or health of the cow. This has also been the experience of nearly all who have applied the test. Cows that have been tested suffer from the same troubles that affect other cows and there is no ground for connecting these troubles with the test that has been made.

In Bulletin No. 42 of the Vermont Agricultural Experiment Station the history of tuberculosis in the Vermont State College herd is given. The first of January, 1894, all but two animals out of a herd of thirty-three were in apparent health. These two had been in an unthrifty condition since coming from the pasture in the fall; tested with tuberculin twenty-four animals reacted and the post mortem confirmed the test. Two animals that failed to react were killed and showed no disease. In the same bulletin it is stated that the station veterinarian during the first six months of last year made over a thousand injections of tuberculin and two hundred and twenty-two animals were found diseased. Two hundred and twenty of these were slaughtered and found tuberculous. Nothing is said about the other two. This is a very remarkable record and does much to confirm the value of tuberculin in detecting tuberculosis. Most of these cases were found in two badly infected herds and of six hundred and sixty-two animals tested, only thirty-nine cases of tuberculosis were found. In Bulletin No. 27 of the Massachusetts Hatch Experiment Station Dr. J. B. Paige gives the results of his experience with tuberculin. The entire college herd was destroyed at different times, the last of them in January, 1894. At this time thirty-two animals were killed, twenty-five of these reacted under the tuberculin test and were found to be tuberculous. The other seven were sound. Of the twenty-five tuberculous animals in no case had the physical symptoms so developed that by any ordinary examination a diagnosis of tuberculosis could have been made. Among the conclusions with which Dr. Paige closes his bulletin are these:

"The diagnosis of most cases of this disease by physical examination is impossible."

"That in tuberculin we have an exceedingly delicate and reliable test for tuberculosis"

"That in tuberculin we have the only means by which we can eradicate tuberculosis from among our cattle."

We might go on to almost any length in giving the results of the use of tuberculin in detecting diseased cattle, and they would all give testimony in the same line as this already given. Many thousands of cattle have been tested in this and other countries by hundreds of different men and the results have been surprisingly uniform. The most unfavorable results we have been able to find any record of were those obtained by the Boston Board of Health at Brighton and Watertown. We have already noticed the conditions were not such at these places as to warrant us in expecting satisfactory results, but they were in a large measure satisfactory, certainly much better than could have been obtained by a physical examination.

The following is from a bulletin by Dr. E. P. Miles published by the Virginia Agricultural Experiment Station.

"The laws necessary to control the disease (tuberculosis) in bovine animals and lessen the mortality in man may be briefly stated as follows:

1st. The most important of all, the establishment of a state board of health, one member of which shall be a qualified veterinarian.

2d. The appointment of a qualified state veterinarian, who shall be an *ex-officio* member of the State Board of Health and work under its direction.

3d. A liberal appropriation placed at the disposal of these officers, in order that they may effectually carry out their work.

4th. The establishment of public abattoirs, and compelling the slaughter of all animals for meat at these places.

5th. Providing for veterinary inspection of all animals slaughtered for meat; also veterinary inspection of all public dairies.

6th. The provision of some means to compensate owners of all condemned animals.

7th. A law empowering the State veterinarian to order the destruction of all condemned animals.

8th. The provision of county hospitals for indigent tuberculous people.

9th. Compulsory disinfection of all premises that have been occupied by tuberculous people or animals.

10th. Compelling the disposal of the carcasses of all tuberculous animals by cremation.

11th. Prohibiting tuberculous people from attending public gatherings in closed buildings.

With these laws in force, tuberculosis can be practically stamped out.

Science is arrayed for the battle; all that is lacking is the declaration of war on the parts of the states and government."

APPENDIX.

The following report on the prevention of bovine tuberculosis was presented to the Massachusetts Veterinary Association, and after thorough discussion and revision, it was finally adopted by the association at a meeting held on November 28, 1894.

Realizing the importance of preventing the extension and continuance of bovine tuberculosis among our dairy herds, the Massachusetts Veterinary Association has prepared the following brochure in the hope that it may assist in spreading information on the prevention and eradication of this disease.

In referring to tuberculosis the following questions are often asked by stock owners: (1) How shall the occurrence of tuberculosis be prevented in a healthy herd, and (2) how shall tuberculosis be eradicated from a herd that is already diseased?

In considering these questions it should be borne in mind that while it is a fact that, no matter how unhealthy the surroundings, bovine tuberculosis cannot exist without the presence of the bacillus, yet it is equally a fact that the germ requires a suitable soil for its development, and that a favorable condition of the body for the development of tuberculosis frequently results from hereditary predisposition, unsanitary surroundings and the injudicious management to which dairy cattle are so often subjected. It follows then that anything that tends to undermine the health of the dairy stock should be avoided and a continual effort made to strengthen and build up the constitution of the dairy cow.

The following recommendations are made to stock owners to prevent the occurrence of tuberculosis in a healthy herd:

1. As far as possible owners should raise their own stock and endeavor to improve the constitution of the herd by breeding only from animals that are strong constitutionally and known to be free from any tuberculosis taint.

2. When practicable all farmers should own a bull. They should restrict its use to their own cows, and not allow it to come in contact with other stock.

3. Allow no strange animal to come in contact with the herd without first making sure by tuberculin test (which is now recog-

nized to be the only practical method of diagnosis) that they are free from disease.

4. Never buy from infected or suspicious herds.

5. Never purchase a cow with a cough or abnormal breathing, lumpy or diseased udder, swollen joints, or with a tendency to scour or bloat.

6. Overcrowding in barns should be avoided. Provide as much air space as possible, allowing at least 1,000 cubic feet for each animal.

7. Pure air and abundant sunlight are essential to the preservation of health in animals. Windows hinged at the bottom and dropped slightly inward at the top may be utilized for light and ventilation. In this way the air is directed upward, thereby preventing a current of cold air on the cattle.

8. In fair weather cattle should be in the open air as much as possible.

9. All barns should be kept as clean as possible. They should be sprinkled before being swept, and in consequence of the irritating and infectious character of the dust of stables in which tuberculous animals have been kept, sweeping should always be done while the cattle are in the yard.

10. In consequence of the danger to cattle from consumptive expectorating in and around barns, no consumptive person should be allowed to have charge of or come in contact with the dairy cattle.

11. Do not keep manure in the cellar. Better have no cellar, but where one exists it should be well drained, well lighted and well ventilated.

12. Manure should be frequently removed from the neighborhood of barns.

13. The barn yard and its surroundings should be well drained and free from standing water and filth.

14. Early breeding, late and continuous breeding, as well as excessive and injudicious feeding and milking, are all frequent predisposing causes and should be avoided.

With reference to the eradication of the disease in herds already affected, it is recommended that a thorough examination of the herd be made, using tuberculin test.

All animals found diseased should be slaughtered and the remaining animals retested at intervals. The thorough disinfection and renovation of all infected barns is imperative and good drainage, light and ventilation should be secured.

Where these conditions cannot be obtained it would in many cases be more economical and satisfactory to build new stables, always observing the recommendations suggested for healthy herds.

ALEX. BURR, M. D. V.,
JAS. B. PAIGE, D. V. S.,
JOHN M. PARKER, D. V. S.,
Committee on Tuberculosis.

In a bulletin lately published in the United States Bureau of Animal Industry, the following methods of disinfection are recommended:

(a) Corrosive sublimate (mecuric chloride,) one ounce in about eight gallons of water (one-tenth per cent.) The water should be kept in wooden tubs or barrels and the sublimate added to it. The whole must be allowed to stand for twenty-four hours, so as to give the sublimate an opportunity to become entirely dissolved. Since this solution is poisonous it should be kept covered up and well guarded. It may be applied with a broom or mop and used freely in all parts of the stable. Since it loses its virtue in proportion to the amount of dirt present, all manure and other dirt should be first removed and the stables well cleaned before applying the disinfectant. After it has been applied the stable should be kept vacant as long as possible. Before the animals are allowed to return it is best to flush those parts which the animals may reach with their tongues to remove any remaining poison.

APPENDIX.

Bulletins Issued in 1894.

BULLETIN No. 6.

FRUIT CULTURE—VARIETIES.

By far the most important branch of fruit growing in this State is that of orchard culture. Soil and climate seem especially adapted to producing apples of the highest quality and appearance, while rocky hillsides, unfit for the general operations of agriculture, are often found to produce the finest fruit. Pears and plums receive but little attention except in isolated localities, while cherries are still more neglected.

The rapidly increasing number of visitors to our State during the summer months, with the consequent increased demand for fresh fruits and vegetables opens a home market for horticultural products which is very encouraging. It therefore seems advisable that the Experiment Station should obtain and disseminate such information as shall be most helpful in building up the several branches of horticultural work.

As is well known, Maine apples have a world wide reputation for quality and beauty. It remains for us to plant such varieties as are likely to prove most valuable; to give the best possible culture to our orchards; to prevent, so far as possible, the attacks of diseases and insect enemies; and to sort and pack our fruit honestly.

Plum growing, which formerly received considerable attention, especially in the Penobscot valley, is again being undertaken in certain sections of the State. It is a remarkable fact, however, that nearly seventy-five per cent of the plum trees reported in reply to recent inquiries, are grown in Aroostook county. If plum growing can be made profitable in those sections of the State where winter protection of the trees is absolutely essential, there would seem to be no good reason for its neglect in other sections which have equally good soil, far more favorable climate, and more available markets. The most serious enemy of the plum grower is the Black Knot, and it is only by concerted action on the part of growers that this disease can be held in check. In New York and some other important plum growing regions, stringent laws have been passed for the protection of the fruit growers, and it is hoped that in the near future similar action may be taken by our own legislature.

Small fruits, especially currants and gooseberries do not receive the attention their importance demands. Both of the fruits named delight in the cool, moist climate afforded by our high latitude and proximity to the ocean, while they are easy of culture and are always in demand at good prices. Strawberries, too, coming as they do after those from Massachusetts and New York are out of the markets, and just as the people are flocking to our summer resorts, offer a promising field to the enterprising fruit grower.

With the above facts in mind, the subjoined list of varieties (condensed from a catalogue of the fruits of the State which will be published in full in our annual report) is sent out as the first of a series of short bulletins on fruit growing; methods of culture; enemies and diseases of fruits; and the varieties best suited to different sections of the State.

The widely varying conditions existing in different parts of the State render a general statement as to the value of any given variety for the State only approximately correct. Varieties which may be of merit in the southern portions of the State are not sufficiently hardy for the middle and northern counties. On the other hand, some sorts considered specially valuable in Aroostook county, are unknown in York.

The following schedules of varieties for the different sections named, are presented after carefully considering the recommendations of leading fruit growers in those sections:

For Aroostook, Piscataquis, Northern Somerset, Penobscot and Washington counties:

APPLES.—Alexander, Dudley's Winter (North Star,) Fameuse, Hayford Sweet, Oldenburg, Yellow Transparent, Wealthy and the

Hyslop and Lady Elgin Crabs. The number of varieties tried and found wanting would form a much longer list.

PEARS.—Only the most hardy will succeed. Fulton, Eastern Belle, Nickerson, and Vermont Beauty are suggested. Pears have not as yet been grown to any extent.

PLUMS.—Damson, Green Gage, Moore Arctic, Smith's Orleans. Of these, Moore Arctic is by far the most valuable, though not of high quality.

SMALL FRUITS.—Agawam blackberry, Cuthbert and Tyler raspberries; Fay and White Grape currants and the Houghton gooseberry lead.

Many other varieties, both of orchard fruits and of small fruits are under trial for this northern region at the present time, and the results obtained will be reported in due season.

For Oxford, Kennebec, Waldo, and the southern counties:

APPLES.—Baldwin, Ben Davis, Gravenstein, Hubbardston, Jewett Red (Nodhead), Mother, Northern Spy, Oldenburg, Red Astrachan, Rhode Island Greening, Tallman Sweet, Yellow Bellefleur.

PEARS.—Angouleme, Anjou, Bartlett, Clapp's Favorite, Lawrence, Louise Bonne of Jersey, Sheldon.

PLUMS.—Bavay, Imperial Gage, Lombard, McLaughlin.

CHERRIES.—Black Heart, Downer's Late, Governor Wood, Early Richmond, English Morello.

RASPBERRIES.—Cuthbert, Golden Queen, Shaffer, Gregg.

BLACKBERRIES.—Agawam, Snyder.

CURRANTS.—Fay, Versaillaise, Victoria, White Grape.

GOOSEBERRIES.—Downing, Houghton, Smith.

STRAWBERRIES.—Bubach No. 5, Crescent, Haverland, Sharpless, Wilson.

GRAPES.—Concord, Green Mountain, Hartford, Moore's Early, Worden.

The above named varieties are the ones most commonly grown at the present time. It is believed that many of these varieties (especially of the small fruits) will soon be superseded by some of the newer introductions, even as the Hovey strawberry, Knevett raspberry, and Dorchester blackberry have given place respectively to the Crescent, the Cuthbert and the Agawam.

A catalogue of all the varieties known to be cultivated in the State with a concise description and the approximate value of each will be published in our annual report for 1893. A copy of this report will be sent to those requesting the same.

W. M. MUNSON,
Horticulturist.

MAINE STATE COLLEGE,
ORONO, ME., Jan. 8, 1894.

BULLETIN No. 8.

SPRAYING EXPERIMENTS.

Spraying with some solution of copper as a protection from the attack of apple scab is coming to be looked upon as a necessity by many of the more progressive orchardists. During the past three seasons the writer has been engaged in solving some of the problems incident to this work. The results, so far as obtained, have been detailed in the annual reports of the experiment station.*

The principal work of the present season was a comparison of the effectiveness of different mixtures. The failure of certain trees, set apart for that purpose, prevented reaching more definite conclusions regarding the best time for spraying.

The materials used in the work here mentioned, were as follows:

1st. *Modified eau celeste.*—2 lbs. copper sulphate, 2 1-2 lbs. carbonate of soda, 1 1-2 pts. ammonia and thirty-five gallons of water.

2nd. *Bordeaux Mixture.*—6 lbs. copper sulphate (Blue Stone), 4 lbs. fresh lime, dissolved separately, then mixed and diluted to 40 gallons.

3. *Bordeaux Mixture and Paris Green.*—Same as No. 2 with addition of Paris green in the proportion of 1 lb. to 250 gallons.

4th. *Paris Green.*—1 lb. Paris Green in 250 gallons water.

The season was very dry and the trees were much freer from scab than in previous years. That there was marked benefit from the treatment is, however, shown in the accompanying photographs of fruit from contiguous trees and also in the table.

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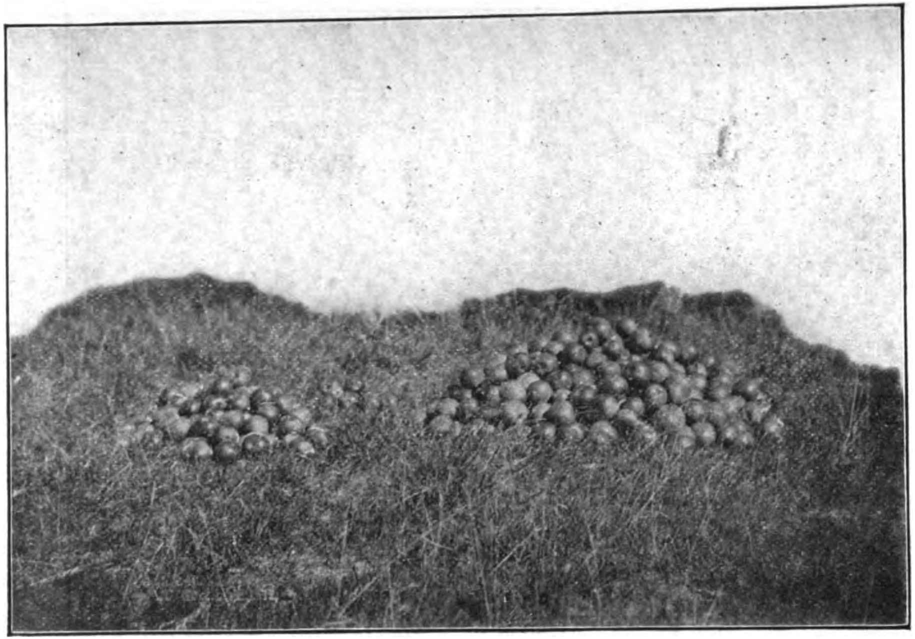
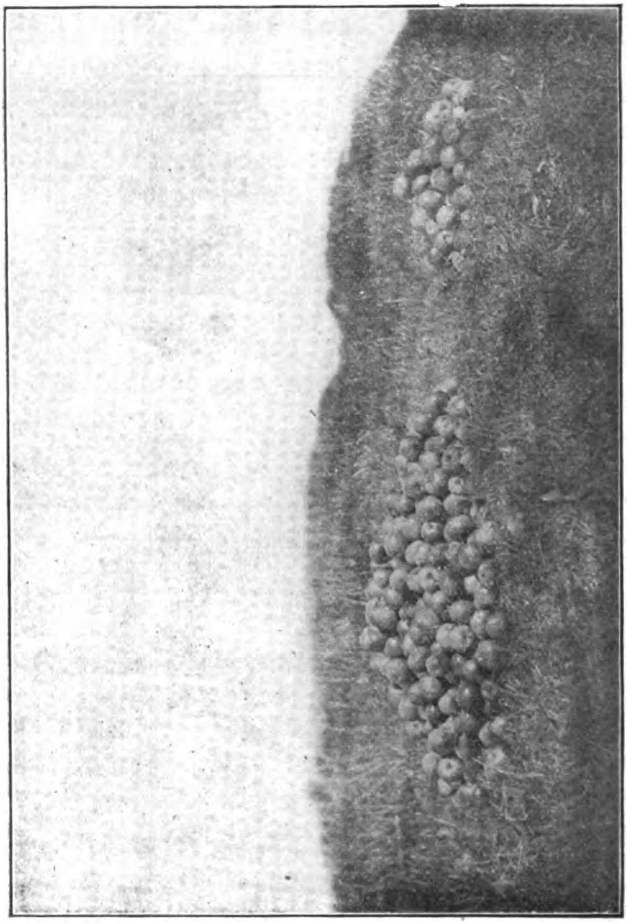
*Rep. Maine Exp. Sta., 1891, p. 112; 1892, p. 92.

NO. 1.—NOT SPRAYED.



Free, 130. Badly scabbed, 17. Slightly scabbed, 592.



No. 2.—SPRAYED.

Free, 474. Badly scabbed, 8. Slightly scabbed, 114.

RESULTS OF SPRAYING TO PREVENT APPLE SCAB. 1893.

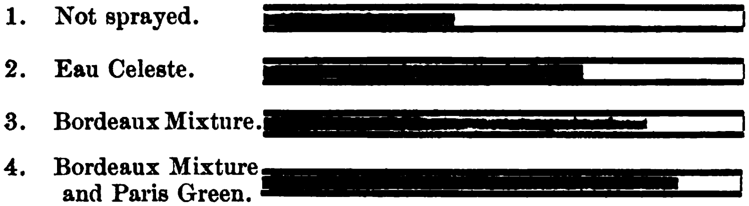
Check trees (not sprayed), -	38.3 per cent. free from scab.
Eau celeste. sprayed four times,	72.8 " " " " "
Bordeaux mixture, sprayed four times, - - - - -	79.9 " " " " "
Bordeaux mixture and Paris green, sprayed four times, - -	82.8 " " " " "

The above figures are the average results obtained from an examination of the fruits of three trees of each class. Much of the fruit classed as "slightly scabbed" in our examinations, hence not considered in the above figures, would grade as "No. 1" fruit. As is well known, however, the fungus grows rapidly after the fruit is packed, hence the rigid adherence to our arbitary distinction.

As shown by the table, the best results were obtained from the use of a combination of Bordeaux mixture and Paris green—a fact which would indicate a possible fungicidal value for Paris green. That this value is slight, however, was shown by some trees sprayed with arsenite only.

The modified *eau celeste*, while less effectual than Bordeaux mixture in preventing scab, was also found to injure the foliage unless used with caution. The fruit also was made somewhat rusty, the epidermis apparently being injured by the ammonia.

The relative value of the different materials used may best be illustrated by the following diagram, the shaded portion representing the per cent. of fruit free from scab:



A BRIEF RETROSPECT.

For the benefit of those who have not received previous reports, it may be well to give a brief resume of the results obtained from three seasons' experiments.

We have seen that apple scab is caused by a parasitic fungus which attacks the leaves and young twigs as well as the fruit, and that the growth of the tree may be seriously checked. Spraying the trees with certain compounds of copper has been found an effective means of holding the disease in check,—the increase of salable fruit, as a result of spraying, often amounting to 50 per cent.

Indications point strongly to the value of spraying early in the season, before the blossoms open, and of repeating the application four or five times during the season.

The best results have been obtained from the use of Bordeaux Mixture, prepared as follows:

6 pounds copper sulphate (Blue Stone),
4 pounds quick lime,
40 gallons water.

Dissolve the copper in a pail of hot water; slake the lime in another vessel; mix and dilute as above for use.

Farmers are advised to club together in the purchase of apparatus and chemicals, thus reducing expense.

Necessary chemicals may be obtained in large quantities of:

Weeks & Potter Co., Boston.
Eimer & Amend, 205 Third Ave., New York.
W. S. Powell & Co., Baltimore, Md.

Most of the materials may be purchased in small amounts at the local drug store.

Force pumps and other apparatus for spraying may be obtained of any of the leading manufacturers, as:

Field Force Pump Co., Lockport, N. Y.
Gould's Manufacturing Co., Seneca Falls, N. Y.
W. & B. Douglass, Middletown, Conn.

The most satisfactory nozzle we have used is the "McGowen," manufactured by John J. McGowen, Ithaca, N. Y. Our second choice is the "Climax," manufactured by the Nixon Nozzle and Machine Co, Dayton, O.

W. M. MUNSON.

MAINE STATE COLLEGE,
Orono, Me, March 1, 1894.

BULLETIN No. 9.

TOMATOES.

Much of the work with tomatoes during the past season was in continuation of experiments previously undertaken, and related principally to methods of culture. The following condensed notes will indicate in a general way the conclusions reached.

1. *Effect of Early Setting*:—Duplicate lots of plants were given the same treatment early in the season. One lot was removed to the field May 23, the other a week later. The first lot was severely checked by frost May 27, but in spite of this fact the plants recovered and there was practically no difference in the yield of the two lots. The slight variation found, was in favor of the early set plants.

Conclusion:—Indications still point to the value of early setting of tomato plants.

2. *Value of Pot Culture*:—The importance of careful handling of tomato plants has previously been emphasized by the writer. During the past season a test was made as to the value of growing plants in pots previous to setting in the field. Twelve plants of each of four varieties were transferred from the seed flats to thumb-pots, later to 3-inch, and then to 4-inch pots, and to the field June 1st. Duplicate lots were handled in boxes in the ordinary manner on the same dates.

In every instance the plants handled in pots produced a larger number of fruits and a greater total weight of the product than those from boxes; but the individual fruits were slightly smaller.

Computing the yield per acre on the basis of the weight of fruit picked previous to October 1st, and considering the plants placed five feet apart each way, we found for the first three varieties, a difference of more than 29 bushels each, in favor of the pot grown plants. This difference at 75 cts. per bushel, (none of our fruit sold for less than 60 cts. per bushel, and early in the season we received $1.75 at wholesale,) would amount to $21.83 per acre, a sum far in excess of the cost of pots and expense of handling.

Conclusion:—There appears to be a marked increase in the productiveness of plants handled in pots previous to setting in the field.

3. *Individual Variation*:—Very often a new variety is recommended, or a particular method of culture is advocated, because excellent results have been obtained for a single season. The danger of drawing conclusions from such limited experience, was pointed out by the writer last year, when it was found that "in no case were the results from duplicate tests uniform."*

Duplicate lots of each of three varieties of tomatoes were grown during the past season. All of these were given the same treatment in the house, and were planted side by side in the field, receiving the same culture. The results obtained, bear out our former conclusions to such an extent, that the results of certain methods of culture undertaken, are withheld for further verification.

The weight of individual fruits was practically uniform, but the variation in number of fruits, and in the consequent weight of the product, was very marked. The date of ripening was also variable.

Conclusion:—The individual variation of plants of any given variety is often such as to obscure any effects of different methods of culture, and render conclusions drawn from a single season's work very unreliable.

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* Rep. Maine Exp. Sta. 1892, p. 64.

† Rep. Maine Exp. Sta. 1892, p. 65.

4. *Crossing*:—The work of developing a tomato which shall be of sufficient earliness to be profitable as a market crop in those sections where the seasons are short, was detailed in our last annual report.† Selections and further crosses were made the past season with interesting and promising results.

The *Lorillard-Peach* cross showed a less marked increase over the pure Lorillard in number of fruits, than was the case in the first generation. In the second generation, the influence of the male parent on the character of the fruit was shown by several individuals which assumed the form and the rough skin of *Peach*. The *Ignotum-Peach* cross showed a similar falling off in the second generation,—the difference amounting to nearly 44 per cent.

5. *Varieties*:—The tomatoes were started in the forcing house March 27. All varieties were given the same treatment while in the house, and were transferred to the open field June 1st. The first ripe fruits were found July 25, on Golden Ball and Long Keeper. Two days later one or more fruits were gathered from Aristocrat, Great B. B., Ithaca and Maule's Earliest.

On October 1st, when the season was practically ended, the following varieties were found, in the order named, to have been the most productive: Golden Ball, Improved Peach, Maule's Earliest, Burpee's Climax, Lorillard, Ithaca and Belmont. Optimus, which was the most productive sort grown last year, stood *ninth* (or dropping the first two varieties, which are of value for amateur culture only, *seventh*) in the list the present season.

The large late varieties, such as Belmont, Buckeye State and Stone, decayed very badly late in the season. The same is true to a certain extent of Ignotum, Matchless and Optimus.

Maule's Earliest and Burpee's Climax were both much smoother than is usual with very early sorts and are promising.

Ithaca and Long Keeper deserve the credit given in previous reports.

Lemon Blush failed to blush and was consequently inferior to Golden Queen.

Buckeye State, Royal Red and Stone, while of merit as individual fruits, are all too late for our short seasons. Ponderosa will also be discarded for similar reasons.

Terra Cotta was of very unsatisfactory quality and is not a firmly fixed variety.

Great B. B., in spite of its name, is a fairly good variety. It decayed badly late in the season.

SUMMARY OF TOMATO NOTES, 1893.

1. The conclusions of former years as to the value of setting tomato plants as early in the spring as possible are confirmed.
2. Plants handled in pots previous to setting in the field are more vigorous and productive than those not so handled,—a fact which may be of great importance to the commercial grower.
3. Individual variation is often such as to render the work of any one season unreliable.
4. The productiveness of any given variety may be largely increased by crossing with some of the smaller less valuable sorts. But this increased productiveness may be partially or wholy lost in a few years even if good culture is given The variety will quickly "run out."
5. It seems possible that seeds from plants grown under high culture in the house, may give better results than those from plants not so treated.
6. By combining the *Lorillard-Currant* hybrid with the Lorillard, the size has been fully doubled and the quality much improved; but there has been a reduction in the number of fruits produced.
7. Of the newer varieties, Burpee's Climax, Maule's Earliest and "B. B." (Brinton's Best) were among the most promising. Buckeye State, Ponderosa, Royal Red and Stone are too late for our climate. Lemon Blush lacked its distinguishing characteristic, and Terra Cotta was of inferior quality.

W. M. MUNSON.

MAINE STATE COLLEGE,
ORONO, ME., March 15, 1894.

BULLETIN No. 10.

CAULIFLOWERS.

The cauliflower is a vegetable highly prized by many, but is too seldom met with in the home gardens of our State. Possessing many of the good qualities of the cabbage, it is to a certain extent lacking in the peculiar rank flavor which renders the former disagreeable to many people. The delicate qualities of the cauliflower are, however, frequently disguised or lost through failure of the housewife to familiarize herself with the best methods of serving. For this reason we send with this bulletin directions for cooking the cauliflower, condensed from material kindly furnished by Miss Anna Barrows, School of Domestic Science, Boston.*

1. *Culture:*—In a general way the culture is the same as for cabbages. Early varieties should be started in the house or hot bed as soon as the first of April. Handle as needed and set in the open field as early as possible—say the 20th of May, setting the plants about two by three feet.

The best soil is a rich, moist, but well drained loam. Like the cabbage, the cauliflower is a gross feeder and demands intense culture. If growth is stopped, from any cause, the heads are liable to "button," or form small sections interspersed with leaves, worthless for market purposes.

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* *Directions for Cooking the Cauliflower.*—A cabbage or cauliflower, unless taken directly from the garden, is much improved if so placed that it can absorb water through its stalk for 12 to 24 hours before cooking. Soak a cauliflower, head down, in cold salted water for an hour before cooking, to draw out any insects that may be concealed. A small cauliflower may be cooked whole and should be placed in the kettle with the flowerets up, as the stalk needs most thorough cooking. A large head should be divided into six or eight sections. Cook in a kettle of rapidly boiling salted water to which may be added one-fourth of a level teaspoonful of soda, (the soda aids in softening the woody fibre). The kettle should be skimmed occasionally while the vegetable is cooking; or, to save trouble, some prefer tying the cauliflower in a thin cloth. An agate or porcelain lined kettle is preferable to iron, which is likely to discolor the cauliflower. The odor is less noticeable if the kettle is left uncovered; the water may also be changed to dispel the odor. A cauliflower should be tender after twenty to thirty minutes of rapid boiling. If overcooked it appears soggy and water-logged.

A good cauliflower, well cooked, requires little additional flavor besides salt and good butter. Some, however, prefer the addition of grated cheese. The cauliflower may also be served as a garnish for meats, in sauces, soups and is excellent cold as a salad. Many prefer it with a thick cream sauce.

"Cold boiled cauliflower is very good fried plain in butter or breaded and fried, or mashed and fried like oyster plant, with the addition of an egg and a palatable seasoning of salt and pepper."

The last paragraph is from Miss Corson's Practical American Cookery. Many other hints may be obtained from this and other leading guides to cookery.

Frequent cultivation is necessary and it is probable that in case of very dry weather about the time of heading, irrigation would be a profitable means of securing a crop, at least for home use. When the heads are about three inches across, the outer leaves should be brought together and held in place by means of a piece of twine or raffia, that the heads may be well bleached.

2. *Influence of Early Treatment of Plants.*—The question as to the value of handling the plants in pots previous to setting in the open field, was considered with reference to the number of heads produced. Four varieties were used in the test with the following results:

In two instances there was a difference of twenty per cent. in favor of the plants grown in pots. One variety gave the same number of heads in each case, but the plants from pots were two or three weeks earlier than the others. The fourth variety gave a slight difference—about seven per cent.—in favor of the box treatment. Doubtless any benefit that might arise from handling plants in pots would lie in the more uniform rate of growth secured.

Conclusion.—Indications point to an increased percentage of marketable heads as a result of handling cauliflower plants in pots during the early stages of growth.

3. *Effects of Trimming.*—The practice of reducing the amount of foliage at the time of removal to the field received attention the past season. The foliage of one lot of each of five varieties was reduced by one-half, while duplicate lots were left without trimming.

As a rule, the per cent. of heads formed was greater from plants not trimmed. There was practically no difference in the earliness of the two lots, nor was there a marked difference in the size of the heads.

Conclusion.—Results obtained will not warrant us in commending the practice of trimming cauliflower plants severely at time of setting in the field.

4. *Varieties.*—Nearly all of the more important varieties of cauliflower were grown in our gardens the past season for purposes of comparison. As was expected, great variation was found in the different varieties and strains of the same type, as regards

earliness, percentage of heads formed, and the character and quality of the heads.

Nearly all of the earliest varieties produced a high percentage of marketable heads, while the late sorts were anything but satisfactory. Of the whole number of varieties grown, sixteen produced more than seventy-five per cent of marketable heads, while with eight varieties every plant produced a good head. Most of the late varieties were checked by the dry weather and showed a tendency to "button," or go to seed.

The following field notes concerning some of the more important varieties were made:

Alabaster (Johnson & Stokes).—Said to be a sport from *Dwarf Erfurt* (see below). A small, early variety, of erect habit, thus permitting of very close planting.

Autumn Giant (Thorburn).—A very large, late variety of excellent quality. Should not be started so early as most other sorts

Best Early (*Burpee's Best Early*, Burpee) —Small, but one of the earliest and surest heading varieties.

Dwarf Erfurt (Thorburn).—Takes its name from the city of Erfurt, Germany, where cauliflowers are extensively grown. One of the most popular early varieties Several strains were grown the past season, of which the best seemed to be Thorburn's Extra Early.

Early Danish (Farquhar).—Of the Erfurt type; forming a medium sized head, very firm and good. One of the best.

Early Paris (Thorburn, Farquhar).—Moderately vigorous, with long stem and of spreading habit. Leaves covered with heavy bluish white bloom, giving the variety a characteristic light shade. Heads of fair size but lacking in solidity.

Giant Purple (Childs).—A large late variety; very attractive when growing and of excellent flavor, but when served its color is objectionable.

Imperial (Landreth).—A medium sized, pure white variety; of spreading habit, heads not sufficiently firm.

Kronk's Perfection (Farquhar).—A very fine strain of the Erfurt type. Of medium size, early, uniform, and in our plantation was among the best.

Landreth First (Landreth).—Of vigorous, erect habit, but having a short stem. Heads of medium size, white, and rather remarkable for uniformity. One of the best.

Livingston's Earliest (Livingston).—One of the earliest. Small but uniform in date of maturity—a valuable consideration in a market variety.

Long Island Beauty (Gregory). A valuable second early sort. Only two cuttings were necessary, and every plant produced a marketable head.

Prize Earliest (Maule).—Three weeks later than some of the other early sorts. Not satisfactory this season.

Snowball (*Early Snowball*, Thorburn).—A moderately vigorous variety forming small but very solid heads. From this type many valuable strains have been derived. One of the most valuable of these is the next mentioned.

Thorburn Gilt Edge (Thorburn).—Not quite so vigorous as the parent, the leaves being slightly smaller and very dense, while the stem is shorter Heads small but of good form and solid. Usually one of the most reliable.

Vaughan's Danish Snowball (Vaughan).—Differs little from *Snowball* mentioned above. Very early and apparently a sure header.

Algiers, Italian Taranto, Late Dutch, London, Nonpareil, Stadtholder and some others, while producing very good individual heads, were not reliable the past season, but will be given further trial.

SUMMARY.

1. The general treatment of the cauliflower is similar to that required by cabbages. Thorough and frequent cultivation are essential. The outer leaves should be brought together and tied a few days before cutting, that the heads may be well bleached.
2. Handling plants in pots before setting in the field increased the percentage of marketable heads.
3. Trimming plants at time of setting is of doubtful value.
4. Early varieties are, as a rule, more certain to produce a satisfactory crop than are the later sorts.
5. The earliest varieties grown the past season were: Burpee's Best Early, Dwarf Danish, Kronk's Perfection and Livingston's Earliest; closely followed by Alabaster, Landreth's First, Long Island Beauty and several strains of Snowball. All of these varieties produced a high percentage of marketable heads.

W. M. MUNSON.

MAINE STATE COLLEGE.
Orono, Me., April 1, 1894.

BULLETIN No. 11.

CORN AS A SILAGE CROP.

The report of the Station for 1891, pp. 41-46, gives a summary of three years' work in testing the relative production of food material by various fodder and root crops. It appeared that the large variety of corn known as Southern White produced the greatest amount of digestible dry substance per acre, excelling root crops, Hungarian Grass and other varieties of corn. Since 1891 a comparison between varieties of corn has been continued. This has been done because the corn crop is an important one to Maine dairymen and because the problems connected with its growth in Maine are local in their nature and cannot be solved by experiments in other states, excepting possibly New Hampshire and Vermont.

The most common question asked in this connection is, Which are the most profitable varieties to grow, the large, which mature only in a latitude south of New England, or the smaller, which complete their growth in this climate?

As set forth in the report previously mentioned, the proper test of productiveness is the yield of digestible dry matter, the gross weight of crop or even of total dry matter being deceptive because of differences in the water content and in digestibility. All effort has been directed, then, towards ascertaining the actual growth of digestible material in the several cases. One other point has necessarily been considered, viz.: The relative value of a pound of digestible material in the crops compared. This latter comparison can most safely be made by feeding experiments, and this has been the method used.

The study of the corn crop has been conducted in 1892 and 1893 in much the same manner as in previous years, only somewhat more comprehensively. The results secured are concisely stated in the accompanying table, all intermediate data, such as size of plots and yield per plot, being omitted. The figures for the three years previous are stated for the sake of comparison.

COMPARATIVE YIELD OF SOUTHERN CORN AND MAINE FIELD CORN, AS GROWN IN MAINE.

	Yield Per Acre.				
	Green corn (whole plant.)	Dry substance.		Digestible dry substance.	
	lbs.	%	lbs.	%	lbs.
Crop of 1888.					
Southern corn	26,295	12.30	3,234.3	65.	2,102.3
Maine field corn	14,212	17.4	2,472.9	70.	1,720.5
Crop of 1890.					
Southern corn	32,950	14.94	4,922.7	69.	3,396.7
Maine field corn	15,300	15.84	2,415.9	71.	1,715.3
Crop of 1891.					
Southern corn	46,340	13.46	6,237.4	61.	3,804.8
Maine field corn	28,080	13.55	3,804.8	73.	2,777.5
Crop of 1892.					
Southern corn, Field 1	37,320	14.67	5,474.8	64.	3,503.9
Southern corn, Field 2	34,820	14.15	4,927.	64.	3,153.2
Maine field corn, Field 1	22,490	20.90	4,700.	78.	3,666.
Maine field corn, Field 2	29,400	18.64	5,480.	76.	4,164.8
Crop of 1893.					
Southern corn, Field 1	39,066	15.45	6,035.7	65.*	3,923.2
Southern corn, Field 2	26,660	16.58	4,420.2	65.*	2,873.1
Maine field corn, Field 1	27,780	25.43	7,064.4	70.	4,945.
Maine field corn, Field 2	18,610	19.50	3,328.9	70.	2,540.2
Southern corn, 7 trials					
Maximum	46,340	16.58	6,237.4	69.	3,923.2
Minimum	26,295	12.30	3,234.3	61.	2,102.3
Average	34,761	14.50	5,036.	65.	3,251.
Maine field corn, 7 trials					
Maximum	29,400	25.43	7,064.4	78.	4,945.
Minimum	14,212	13.55	2,415.2	70.	1,715.3
Average	22,269	18.75	4,224.	73.	3,076.

* The average of previous years.

The foregoing figures show a large variation in production in different years, under conditions other than the season, quite uniform. This variation is not alone in gross weight of crop, but in dry matter as well. The largest quantity of dry matter produced in any case during the five years is nearly three times that yielded by the smallest crop. This is in part due to manuring and cultivation and in part to the character of the season.

Had these experiments been discontinued after 1891 the outcome would have been decidedly favorable to the large variety of Dent corn, but in 1892 and 1893 the relation of yield has been reversed and the smaller variety of Flint corn has taken the lead. It is probable that another five years' series of comparisons would furnish a somewhat similar experience.

The general outcome for the five years is slightly favorable to the large variety of corn if we consider only the yield of digestible dry matter. But when we take account of the fact that in the one case an average of five and one-half tons more of material have annually been handled over several times, we are led to conclude that the smaller, less watery variety of corn has really proved the more profitable. It is significant, also, that the largest yield of dry matter in any instance has been from the small variety. While the Flint corn grown in this State is not capable of storing so much dry substance as the large varieties of Dent corn, under circumstances equally favorable for both, the latter cannot in this latitude reach anything like maturity, and so loses the advantage of that period when growth is most rapid.

SUMMARY.

(1). The average weight per acre of the green crops for five years were: Southern Corn, 34,761 lbs.; Maine Field Corn, 22,269 lbs.; difference, 11,492 lbs., or nearly five and three-fourths tons.

(2). The average dry matter per hundred pounds was nearly one-third more in the Maine Field Corn, the relation being Southern Corn, 14.50 lbs.; Maine Field Corn, 18.75 lbs., or as 100 : 129.

(3). The Maine Field Corn proved to be the more digestible, the relation for dry matter being: Southern Corn, 65 per cent; Maine Corn, 73 per cent., or as 100 : 112.

(4). The average pounds of digestible dry matter per hundred pounds of green corn have been: Southern Corn, 7.25 lbs.; Maine Field Corn, 13.69 lbs., or as 100 : 189.

(5). The average yield of dry matter per acre has been: Southern Corn, 5,036 lbs.; Maine Field Corn, 4,224 lbs.

(6). The average yield of *digestible* dry matter has been: Southern Corn, 3,251 lbs.; Maine Field Corn, 3,076.

(7). The yield of digestible dry matter has averaged 175 lbs. more with the Southern Corn. To offset this it has been necessary to handle annually five and three-fourths tons more weight.

(8). The largest as well as the smallest yield of digestible matter in a single year has come from the Maine Field Corn.

W. H. JORDAN.

MAINE STATE COLLEGE,
ORONO, ME., April 2, 1894.

BULLETIN No. 12.

POTATOES.

A COMPARISON OF THE TRENCH SYSTEM WITH ORDINARY CULTURE.

A few years ago considerable interest was aroused by the accounts of wonderful yields of potatoes obtained by a method of culture known as the Rural New Yorker trench system. The system derives its name from the fact that it was first used at the trial grounds of the Rural New Yorker and was advocated by the editor of that paper, Mr. E. S. Carman.

The system consists essentially in planting the tubers in trenches five to seven inches deep and twelve to fifteen inches wide, the bottoms of which are well pulverized; covering to the depth of about two inches; then applying any desired amount of fertilizer in the trench, after which the trenches are filled so that the surface shall be level.

Now it has been the practice of the writer for several years to plant in furrows, applying fertilizer broadcast over the surface of the ground; for there is little doubt that the old custom of "hilling" potatoes is worse than useless,—it is positively injurious to the crop on dry soil. It has seemed doubtful in view of the fact that the roots of the potato extend in all directions, filling the whole space between the rows, whether placing the fertilizer in a trench only could be as rational or in practice as satisfactory as the other method.

In the paper referred to and also in a book recently published,* the statement is made that "In every trial the land laid out in trenches, whether with or without fertilizer or manure, has largely outyielded that planted according to the old method of hills or furrows."

In an issue of the Rural New Yorker of recent date is a detailed account of a comparison of the two methods as conducted on the grounds of the originator of the trench system. From this trial the following conclusions were drawn: "There is a difference of the total yield per acre of only one-half bushel (.49) in favor of the trenches but of the marketable potatoes there is a difference of over seventeen bushels per acre in favor of the trenches.

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* The New Potato Culture, p. 35.

"The yield of small potatoes (unmarketable) of the furrows is 16.79 bushels per acre greater than that of the trenches."*

The work of this station, planned without the knowledge that similar work was being undertaken elsewhere, is detailed below.

On a piece of sandy loam, having a southern aspect, alternate rows of the variety named below were planted three and one-half feet apart—one being "trenched," the other planted in an ordinary furrow. The rows trenched were plowed about a foot wide and eight inches deep, after which the soil in the bottom of the furrow was loosened and pulverized, some of the earth being worked back into the furrow. The "seed," cut to two eyes, was then planted one foot apart in the row. The pieces were covered to a depth of about two inches, when a complete fertilizer at the rate of one thousand pounds per acre was scattered in the trenches, and the trenches were filled.

The other rows were simply plowed, the seed pieces dropped and covered, when the same amount of fertilizer as before was scattered on the surface. As soon as the young shoots appeared above the surface a smoothing harrow was used and thorough culture was given until about the middle of July, when the vines covered the ground sufficiently to keep the weeds down and serve as a mulch for themselves.

The comparative results are shown in the accompanying table:

TRENCH SYSTEM VS. ORDINARY CULTURE OF POTATOES.

VARIETY AND SYSTEM.	Weight of product—pounds.	Weight of marketable tubers—pounds.	Weight of small tubers—pounds.	Average number of marketable tubers per hill.	Yield per acre of marketable tubers—bushels.	Yield per acre of small tubers—bushels.
EARLY ROSE.						
No. 1. Furrow	58.87	51.03	7.84	5.6	234.4	34.6
Trench	61.48	53.24	8.24	5.0	244.8	37.9
No. 2. Furrow	80.00	71.00	9.00	6.9	327.7	41.5
Trench	79.23	68.72	10.51	6.1	317.4	48.5
CRANE'S JUNE.						
No. 1. Furrow	69.90	62.00	7.90	6.0	286.2	36.3
Trench	66.30	54.81	11.49	5.2	253.1	52.9
No. 2. Furrow	70.19	58.45	11.74	5.9	269.6	54.1
Trench	71.57	61.04	10.53	5.8	282.1	48.5
HEBRON.						
Furrow	64.15	59.12	5.03	5.4	271.7	23.2
Trench	74.07	65.16	8.91	5.4	300.8	41.1

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*Rural New Yorker, Oct. 14, '93, p. 683.

In every instance duplicate lots produced contradictory results. The first lot of Early Rose gave a greater yield from the trench—the difference being nearly ten bushels of marketable tubers per acre. The second lot reverses these figures, so far as the marketable tubers are concerned, but the increased number of small potatoes makes the total yield practically the same with the two methods of treatment.

The first of Crane's June gave a difference of thirty-three bushels of marketable tubers per acre, in favor of the furrow; while in the second lot the trench produced at the rate of twelve bushels per acre more than the other.

In each instance above mentioned the number of marketable tubers per hill was slightly smaller in the trenches and the weight of individual tubers was somewhat greater. On the other hand, with one exception, the small tubers from the trenches exceeded in weight and number those from the furrow.

Hebron, from the trench was superior to the same variety from the furrow. The number of tubers per hill was the same but the individual tubers from the trench were so much superior as to be equivalent to an excess of twenty-nine bushels per acre over the other.

It will be seen that these facts are, in a measure, opposed to conclusions concerning the system which have heretofore been published. We would not, however, condemn the method without further trial; though it is but just to say that certain parties quoted as obtaining specially marked results from the trench system have discarded this method in general practice.

Conclusion:—It is questionable whether the results obtained will justify the extra labor involved in practicing the trench system of potato culture. In our trials the past season duplicate lots in every instance produced contradictory results.

W. M. MUNSON.

MAINE STATE COLLEGE,
Orono, Me., May 1, 1894.

BULLETIN No. 13.

THE SUPPRESSION OF BOVINE TUBERCULOSIS AND GLANDERS.

The object in writing this bulletin is to call attention to the modern, and, in most cases the only, methods of determining whether animals are suffering from these diseases. But little reference is made to the general symptoms of the diseases, for although volumes might and have been written describing the symptoms that are sometimes noticed, it is a well known fact that in many cases, particularly in tuberculosis, there are no symptoms that would either attract the attention of the owner or that can be detected by the most skillful veterinarian, and in this obscurity lies the chief danger. A long description of inconstant symptoms will tend to obscure the points presented here and would accomplish nothing. Any inquiries regarding diseased animals, accompanied by a description of the symptoms, the Experiment Station will be ready to answer at any time.

Tuberculosis of cattle is a widely distributed disease differing in no very essential particular from tuberculosis of other animals. It is transmitted from sick to well cattle through the matter coughed out and through the milk, and very rarely directly from parent to offspring by inheritance. On account of the conditions under which they are kept, dairy cattle are most subject to the disease and in general it is most prevalent among cattle where consumption and other forms of human tuberculosis most prevail. On the other hand, it seems to be true that human tuberculosis is most prevalent where the meat and milk of tuberculous cattle are used for human food. The statement is made that among some reservation Indians where diseased meat is freely eaten, the death rate from tuberculosis is one-half of all the deaths.

There are two principal reasons why every effort should be made to suppress bovine tuberculosis. 1st: It should be done to protect healthy cattle that are continually being exposed; and 2d: It should be done to save the many thousands of human lives that are yearly sacrificed to consumption contracted and fostered by milk, meat, etc., from tuberculous cattle. It is certainly true that either of these reasons offers grounds sufficient to warrant the adoption of even what may seem to some to be extreme measures to suppress this terrible scourge. If it could be shown that as a state we were entirely free from obvine tuberculosis and sufficient means were being used to preserve that freedom, it would create such a demand for our dairy stock as would compensate us for all the expense involved and we would not be subject in any such measure to the continual losses that we now have to meet from this cause. If any of our breeders have an ambition to improve their stock and go out to purchase animals to this end, they stand about an even chance of ruining their herd and business by introducing tuberculosis with the improved blood. Many instances of this sort might be mentioned as having occurred in this State, and it is safe to say many more will occur unless measures are taken to prevent it. Many of our most progressive dairymen and stock breeders have run against this snag in their business, and have either been obliged to dispose of their stock at a loss to themselves or to those who purchased it, or to continue breeding from diseased stock—a course which deserves to be condemned from every standpoint of policy and safety.

One tuberculous cow introduced into a large dairy herd has often been the means of contaminating most of the herd, and one diseased herd of choice animals where the calves are raised and sold has often been the means of introducing tuberculosis into many herds, to the material loss of the owners. A much more serious reason than the purely financial one why every effort should be made to suppress bovine tuberculosis is the close relation it bears to the same disease in human beings.

Every tuberculous cow is a menace not only to the health of other cattle, but to the lives of human beings. Bovine tuberculosis is not perhaps the greatest factor in causing human tuberculosis, but it is an important factor. It is possible to demonstrate beyond a reasonable doubt that thousands of children and adults die each year as a direct result of bovine tuberculosis. Tuberculosis of cattle and human beings is the same disease, due to the same cause, bacillus tuberculosis. This bacillus thrown off from the lungs of consumptives, coughed out by tuberculous cattle, in the milk of consumptive mothers, or in the milk or flesh of diseased cattle, has the same power to set up disease in susceptible animals without regard to its source. When we consider that during the one year of 1892 in this State alone, 1,513* human beings died from pulmonary and other forms of tuberculosis and that 1892 was probably not an exceptional year in this regard, we ought to awake to the importance of removing the cause of this great fatality as far as possible. This was the year in which grip raged to such an unusual and alarming extent, yet the grip caused less than half (755)* this number of deaths and all other forms of contagious diseases combined did not prove so fatal as tuberculosis.

If the much dreaded disease, small pox or Asiatic cholera, should gain a foothold in our State and for one year cause half the havoc that tuberculosis does every year, the State and nation would combine to use every available means to check it, and they would succeed. Now tuberculosis is a more surely fatal disease than either of these, but just as surely preventable, and, if through long and continuous familiarity with it we had not come to regard its ravages as almost inevitable, we might be comparatively free of it within five years. Dr. Law says "Tuberculosis is allowed to continue its career of death only because of reprehensible ignorance and criminal indifference." (Cornell University, Agricultural Experiment Station, Bulletin No. 65.)

The greatest obstacle to the suppression of bovine tuberculosis next to "criminal indifference" has been the difficulty in determining what animals were affected and what were healthy. We have had no means by which we could detect the early stages of the disease. If a cow were well fed and cared for she might for years be a source of contagion in a herd and a menace to the health of human beings, without her true condition being known. This difficulty in detecting the disease made it practically impossible to get rid of it. The most that could be done was to kill off the advanced cases as soon as they could be detected. Now, however, this is changed. We have a method by which it is possible to detect tuberculosis in cattle in any of its stages with a very high degree of certainty. If there are any cases that cannot be detected by this means, they are either so advanced that the merest novice will have no difficulty in diagnosing them by a physical examination, or, the animals are very slightly affected, the disease for the time being making no progress, so that for practical purposes they can hardly be considered diseased.

In this brief bulletin it is impossible to describe in detail the method by which the diagnosis of tuberculosis in cattle is made easy and certain. It is perhaps sufficient to say that by the simple injection of a twentieth of a gram of tuberculin underneath the skin of a cow there will be a marked rise of temperature within from nine to fifteen hours, provided she has tuberculosis, and not otherwise. Tuberculin, the diagnostic agent, is a chemical substance, that in the dose given has not the slightest injurious effect upon well animals. There are certain precautions to be taken to avoid mistakes, and some degree of skill and familiarity with the diseased conditions of cattle is necessary on the part of one making the test, but with suitable instruments and professional skill it is comparatively easy for one man to examine a herd of fifty animals in less than twenty-four hours and detect every case of tuberculosis that may exist there. Thus we see that the problem of suppressing bovine tuberculosis, we will not say the complete extermination, for this will be impossible while other tuberculous subjects are allowed to freely distribute the seeds of disease, resolves itself into the simple testing of all bovines with tuberculin; and as soon as the public mind is awakened to the true importance of the work this will be done, and the tests will be repeated sufficiently often to keep the disease in check. Public sentiment that will demand the suppression of what has long been regarded as an inevitable evil may be slowly developed, but its development is sure when the work to be accomplished is so simple and important as the suppression of tuberculosis.

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*Report of State Board of Health for 1893.

But if radical and generally applicable measures are not at once in operation to do away with this disease, there is no reason why individuals should not protect their own herds and the lives of their families and patrons by making sure that they are not harboring it. A man who will buy and keep a family cow to supply milk and butter for his children and not adopt the simple and inexpensive measures necessary to be sure she is not affected with tuberculosis is either ignorant of the danger incurred or guilty of negligence little short of criminal. The dairy man who is supplying the public. including invalids and children, who are particularly susceptible to consumption, with milk or butter, who will not go to the slight expense necessary to test his herd for tuberculosis, has neither a proper regard for his own or patrons' interest; and, particularly, the breeder of choice dairy stock that will continue to breed and distribute among other herds cattle that may, and, as experience has shown, are particularly liable to carry with them the seeds of tuberculosis, is not deserving of public confidence. Any one can purchase tuberculin from some of the leading druggists and also the necessary instruments with which to administer it, but we would advise the average farmer and stock owner not to undertake a test of this importance, the complete success of which depends upon experience and professional skill. It would be better to employ a competent veterinary surgeon. The expense ought not to be very great. For the present, as far as other work will permit, the Experiment Station will undertake to examine cattle for tuberculosis in any part of the State where the owner will pay travelling expenses. We cannot promise to continue to do this indefinitely, but for the next few months, for the purpose of obtaining data relative to the prevalence of tuberculosis among our cattle, we hope to be able to answer all calls in this direction. It is possible that arrangements can be made to examine a limited number of large herds free of all expense to the owner. After a herd is once free from tuberculosis, we can only be sure of keeping it free by attention to the following details:

1st. Have the barn thoroughly disinfected. 2nd. Retest the herd at intervals. 3rd. Test all purchased animals before adding them to the herd.

GLANDERS.

This is a disease prevailing among horses and mules, and transmitted from them to some other domestic animals and to man. Cattle are not subject to it. In a very general way it bears some resemblance to tuberculosis. Its presence has often been difficult and even impossible to determine. Horses are sometimes affected with it for years, and carry the disease to other horses without manifesting any symptoms that lay them open to suspicion. The disease is conveyed to man and other animals brought into contact with the diseased one chiefly through the nasal discharges and from ulcerating lymphatic glands. Recoveries from glanders are probably less frequent than from tuberculosis, and when transmitted to human beings it usually assumes an acute and speedily fatal form. The glanders bacillus is the active source of this disease and this bacillus is given off from diseased animals, chiefly in the nasal discharge and in the discharge from the ulcerated lympathic glands Well animals contract the disease by introducing into their systems in some way the glanders bacilli contained in these discharges. The disease is most prevalent where large numbers of horses and mules are found closely associated in confinement. Here the conditions are most favorable for the spread of the disease, but as horses circulate quite freely from city to country districts, public watering troughs and feed stables where transient boarders are kept also have their share in spreading the disease. Through this State cases are continually appearing in such advanced condition that they cannot be mistaken for anything else and they are killed How many other affected animals escape detection and are not even suspected of being glandered, nobody can tell, but it must be a considerable number. In any suspected case or in the case of any animal where it is desired to know positively whether the horse is suffering from glanders we now have a sure test similar in nature to that by which we determine the presence of tuberculosis. A very small quantity of a chemical substance called mallein injected into a glandered horse causes a rise of temperature and a local swelling at the point of the injection, while if the horse is sound the small dose of the mallein used apparently has no effect. The discovery of the value of mallein in diagnosing glanders followed soon after the discovery of tuberculin, and while of less importance, is nevertheless of great value. In stables where one horse among many is found to have glanders we can with mallein make sure that no obscure cases are allowed to remain. By this test prized family horses suspected of having glanders can often be shown to be free of it, and none of the wiles of the tricky dealer will be able to disguise glanders so that this test well made will not reveal it.

SUMMARY.

1. This bulletin is for the purpose of calling attention to a satisfactory method of determining the presence of tuberculosis in cattle and glanders in horses.
2. Tuberculosis is a widely distributed disease common to man and other animals and readily transmitted from one to the other.
3. Tuberculosis is spread among cattle and from cattle to man by the material coughed out from the lungs and by the milk and flesh of affected cattle.
4. Bovine tuberculosis should be suppressed as a measure of economy and to prevent sacrifice of human lives.
5. By a physical examination tuberculosis in cattle can only be detected in advanced stages.

6. By means of tuberculin it can be readily detected in all stages.

7. The tuberculin test is simple, harmless and conclusive and should be used to test all cattle in the State and all imported animals before they are introduced into new herds.

8. The Experiment Station will for a time undertake to test cattle for any who may desire, at the simple cost of traveling expenses.

9. Glanders is often an obscure disease with no well marked symptoms.

10. Glanders may be transmitted from affected horses and mules to man by means of the discharge from the nostrils or from ulcerated lymphatic glands.

11. Glanders is most prevalent in large cities but is often conveyed by the sale of affected horses into country towns.

12. Mallein serves as a sure test of the presence of glanders.

13. Mallein can be used with no risk and slight expense.

F. L. RUSSELL.

MAINE STATE COLLEGE,
Orono, Me., June 1, 1894.

BULLETIN No. 15.

A SCHEME FOR PAYING FOR CREAM BY THE BABCOCK TEST IN BUTTER FACTORIES.

J. M. BARTLETT.

Several of the butter factories in this State are already employing this test to determine the butter value of the cream furnished by their patrons and are making use of those values as a basis of payment. In some cases considerable confusion and dissatisfaction have arisen between the patrons and managers of the factories, due in some cases to a misunderstanding on the part of the former and in some few instances to an improper handling of the test on the part of the latter. We feel it our duty to state here that no person should even attempt to employ the test as a basis of payment until he has thoroughly mastered it and has convinced himself that he can obtain correct results. It would be better in all cases if he could secure instruction from some person competent to give it, than to try to work it out by himself.

Another and the principal cause of confusion and misunderstanding has been the many systems employed by the different factories for applying the test in a practical way, and as it is evident that this will soon be the universal method of paying for cream and milk it seems absolutely essential that some good and uniform system should be adopted.

The object of this bulletin therefore, is to present what we consider the best system for this important work and which is, practically, the one in general use in milk gathering creameries. In this system the cream is to be bought by weight as we believe it simpler, more accurate and just as rapid to weigh with one of the spring scales which can be found in most hardware stores, than to measure by any system now in use.

APPARATUS FOR SAMPLING AND WEIGHING.

Pail for Weighing.—For this purpose we would suggest a light pail not more than nine or ten inches in diameter and eighteen to twenty inches deep, having a strong bail, a lip or nose on the top and handle near the bottom to assist in emptying. It should be made of light material and strengthened at the top by a hoop to avoid denting when being emptied and should weigh five pounds.

This will hold easily fifty pounds of cream, which is as much as the collector cares to handle.

Scale for Weighing.—There are several spring scales on the market that doubtless are good for this purpose, but the best we have seen is a Chatillon spring scale that has a dial and will weigh up to sixty pounds.

The indicator can be set back so it will stand at zero when the pail is attached. The figures to which it points after the cream is put in will be the weight of the cream.

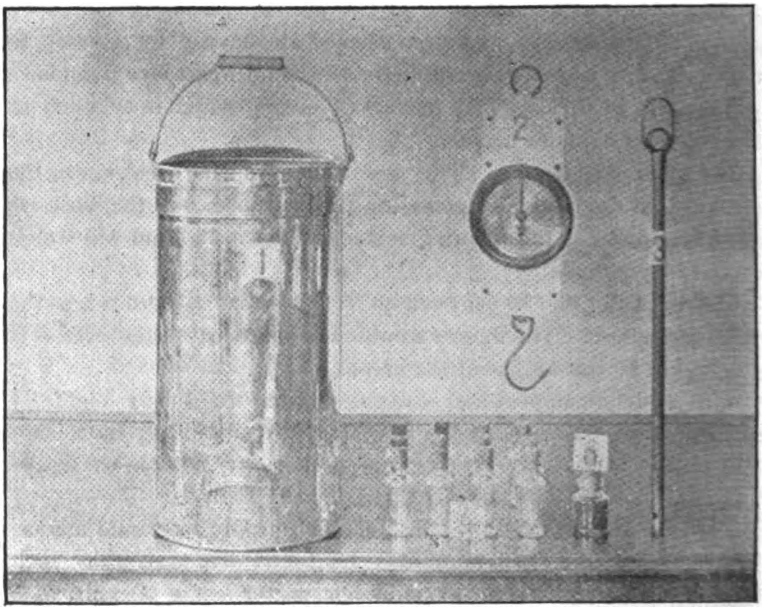
This scale is compact and can be carried in a box eight by fifteen inches. In making the weighing, it can be hung on a support on the back of the collector's wagon or on a hook in the dairy that is high enough to allow the pail to hang clear.

Tube for Taking the Sample.—For this purpose we would recommend a metal tube about two feet long and five-sixteenths inch inside diameter, provided with a stopper at the lower opening that can be worked at the top by a small rod running down through the large tube.

Bottle for Carrying the Sample.—We prefer a two-ounce, wide mouthed bottle, made of strong glass and provided with a cork stopper. A case should be provided for these bottle with pockets to prevent them from rattling around, and a closely fitting cover to protect them from cold weather in winter. Each bottle should be given the number of the patron for whom it is to be used.

SAMPLING FOR THE TEST.

Manipulation.—After the cream has been turned into the weighing pail, the sample is taken by letting the sampling tube, with the lower end open, *slowly* down to the bottom of the pail. The lower opening is then closed, the tube taken out, allowed to drain a moment and the contents run into the bottle marked with the patron's number. It is very essential that this tube be let down slowly and that the lower end be open, so it will fill as it goes down, taking a section of the cream through the whole column and insuring a correct sample. If the tube is let down quickly, or with the lower end closed, and then allowed to fill from



COLLECTOR'S OUTFIT.

1. Pail for weighing. 2. Scale. 3. Sampling tube. 4. Sample bottles. 5. Preservative (bichromate of potash).

the bottom of the pail, it is possible to get a sample much less rich in fat than the top would yield. If there is more than one pail of cream, a portion should be taken from each and every lot weighed out. If a tube full from every lot more than fills the sample bottle, then all the portions drawn should be mixed in a dish large enough to hold them and the bottle filled from the mixture. In any case enough should be taken to fill the sample bottle to prevent churning on the road.

Preservative.—For this purpose we would recommend bichromate of potash. After the sampling bottles are thoroughly cleaned with hot water and washing soda, a small amount, about what can be held on one-quarter inch of the blade of a penknife, of the finely powdered bichromate of potash should be put in each bottle before starting out to collect cream, then if the cream is perfectly sweet and well shaken up after being put in the bottle, it will keep sweet two weeks if kept in a cool place. Cream that is sour should not be sampled, as it is impossible for a collector to get a fair sample of it in any reasonable length of time. If it has become thick it cannot be mixed by the collector so it will be uniform, and cannot be sampled with the tube. Creamery managers should insist that their patrons keep their cream sweet until it is taken by the collector. This is essential not only to correct sampling, but to making a good quality of butter.

Composite Sample.—The composite sample is made up from the small samples taken by the collector and is the one from which the portion is taken for the test. Half-pint fruit jars are good receptacles in which to put these samples, and each one should be numbered with the patron's number, the same as the small bottles used by the collector.

The small samples are taken every time cream is collected according to the directions previously given, and as soon as they arrive at the factory they are emptied into the fruit jars having corresponding numbers. The jar should be closed tightly to prevent evaporation. At the end of two weeks, if one chooses to test as often as that, these accumulated small samples constitute the composite sample and the per cent of butter fat found in this sample will be the average per cent in all the cream furnished by the patron having that number for that period.

In winter, or if the composite sample be kept in an ice chest with the preservative, it could be kept four weeks as easily as two, thereby reducing the work of testing one-half.

Paying for the Cream.—The majority of our creameries in this State are co-operative and therefore the profits are divided among the patrons in proportion to the amount of butter fat furnished. With this class of creameries the simplest method of dividing profits is as follows, and is best presented by an illustration:

Suppose we have a creamery with A, B and C as patrons.

A furnishes for one month 400 lbs. cream testing 20% butter fat.
B “ “ “ “ 500 “ “ “ 18% “ “
C “ “ “ “ 600 “ “ “ 15% “ “

Then A furnishes $400 \times .20 = 80$ lbs. butter fat.
“ B “ $500 \times .18 = 90$ “ “ “
“ C “ $600 \times .15 = 90$ “ “ “
Total received, 260 “ “ “

The net profits from the sale of butter and cream for the month are $70.

Then A is entitled to $\frac{80}{260}$ of \$70 = \$21.53$\frac{1}{13}$.
“ B “ “ “ $\frac{90}{260}$ “ \$70 = \$24.23$\frac{1}{13}$.
“ C “ “ “ $\frac{90}{260}$ “ \$70 = \$24.23$\frac{1}{13}$.

In case the creamery is not co-operative and the proprietor wishes to fix a price for the cream according to the market price for butter, then all that is necessary is to fix the price for the butter fat. Good creamery butter should on the average contain 83 per cent of butter fat, then if butter is 20 cents per pound, butter fat would be worth 24.1 cents which is calculated by the following proportion:

83 : 100 : : price of butter : price of butter fat.
83 : 100 : : 20 cents : 24.1 cents.

When the cream is weighed and the per cent of butter fat determined the value of the cream is very easily calculated and the process should be readily understood by everyone. The product of the weight of the cream multiplied by the per cent of fat will be the weight of the fat and this product multiplied by the price of fat per pound will be the value of the cream.

BULLETIN No. 16.

INVESTIGATION ON THE FORAGING POWERS OF SOME AGRICULTURAL PLANTS FOR PHOSPHORIC ACID.*

Prof. Walter Balentine.

Of recent investigations in plant nutrition those establishing the fact that leguminous plants are able to gather a portion of their nitrogen either directly or indirectly from the free nitrogen of the air are by far the most important, both from the scientific and the practical stand points.

These investigations settle a question that has attracted the attention of agricultural chemists for half a century. On the practical side the results enable us to say, that it is possible, by growing and feeding to farm animals such plants as peas and clover, to increase the stock of nitrogen for manurial purposes without resorting to the various expensive commercial nitrogenous materials.

Stating the results of these investigations concisely, it has been found that the leguminous plants are able to forage on the atmosphere for a portion of their nitrogen. Other plants either possess this power to a much less degree or not at all. If we look for a reason why this family of plants has attracted so much attention from scientists we find it in the fact that some of its members, the clovers especially, have been found in practical farming to be plants which by their growth on the soil, apparently leave it richer in plant food than before, and that farmers are actually able to produce more of grass, grain and potatoes when clover is used as one of the crops in rotation. It was to learn why a plant that takes up such large quantities of nitrogen as clover, should still leave the ground in a better condition for succeeding crops, that the sources of supply of nitrogen to the leguminous plants have been so carefully studied.

The value of the results of this work to the agriculture of the world cannot be over-estimated. There are, however, other problems in plant nutrition which deserve as careful study as the nitrogen question and which may yield results of equal practical importance.

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*This bulletin is an extract from the report of Prof. Balentine in the Station report for 1893.—W. H. J.

All who have given especial attention to the subject of plant nutrition will, undoubtedly, agree that the foraging powers of plants for the elements contained in the ash, vary greatly. This fact is recognized by the majority of observing farmers, as is shown by the following common sayings: "Wheat requires a rich soil." "Corn is a gross feeder." "Oats are an exhaustive crop."

Notwithstanding that these views regarding the variation in foraging powers of different crops have been held by many for years, no one is prepared to say just how it is exerted. We are hardly ready to express an opinion whether the greater vigor of certain plants as compared to other species grown on the same soil is due to their superior foraging powers for all of the elements contained in their ash, or for one or more particular elements.

It seems quite as likely, however, that some plants are able to use certain soil compounds of potash or phosphoric acid, which are not available to other plants, as it did that the legumes were able to obtain nitrogen from sources that were not available to the grasses.

Believing that a study of the foraging powers of different agricultural plants would reveal facts of scientific interest, and at the same time of practical value to agriculture, the writer commenced a series of experiments, in the fall of 1892, designed to test the readiness with which different plants obtain their phosphoric acid from insoluble phosphates.

The reason why phosphoric acid was selected on which to make these first studies, in preference to any other substance was, that in practical manuring with crude phosphates, and also in their use in experimental work, different crops had apparently showed decided differences in their abilities to gather phosphoric acid from such a source.

EXPERIMENTAL METHODS.

In order to have the work as much as possible under control the experiments were conducted in boxes in the college forcing house. These boxes were of wood, fifteen inches square and twelve inches deep. For soil a fine sand was used, taken from a sand bank about three feet below the surface. This sand was drawn to the forcing house, screened and thoroughly mixed by repeatedly shoveling it over, after which a sample was taken and the contents of potash and phosphoric acid determined, with the following result: Potash, 0.096; phosphoric acid, 0.012 per cent.

One hundred and twenty pounds of sand were used in each box.

For each kind of plant studied nine boxes were used, in three sets of three boxes each.

The three boxes of each set received the following manuring per box:

SET I
8.5 grams nitrate of soda = 1.36 grams nitrogen.
2.6 grams muriate of potash = 1.36 grams potash.

SET II
8.5 grams nitrate of soda = 1.36 grams nitrogen.
2.6 grams muriate of potash = 2.36 grams potash.
17.0 grams South Carolina rock = 4.35 grams insoluble phosphoric acid.

SET III
8.5 grams nitrate of soda = 1.36 grams nitrogen.
2.6 grams muriate of potash = 1.36 grams potash.
28.5 grams acidulated South Carolina rock = 4.46 grams phosphoric acid, three-fourths water-soluble.

It will be seen that all of the boxes were treated alike with reference to potash and nitrogen, that the plants grown in Set I were dependent on the phosphoric acid originally in the sand, that those grown in Set II had in addition 4.32 grams of phosphoric acid, mostly insoluble, supplied by crude finely ground South Carolina rock, and that those grown in the boxes of Set III had in addition to that originally contained in the sand 4.46 grams of phosphoric acid, mostly soluble, supplied in acidulated South Carolina rock.

The plants thus far studied have been wheat, barley, corn, beans, peas, potatoes and turnips.

After planting, the boxes were under the care of a man experienced in growing plants under glass. Water was supplied as it was believed to be needed. At the proper time the plants were thinned so that the boxes having the same kind of plants contained the same number of plants to the box.

The plants were allowed to grow to maturity. Immediately before harvesting, the crops were photographed and plates made showing the relative development of the plants produced. At the time of harvesting, the crops of wheat, barley, corn, peas and beans produced in each box were wieghed separately in an air dry condition, after which the amount of dry matter was determined in the combined crop of the three boxes of each set.

	Dry matter produced in each set of three boxes.						
	Wheat.	Barley.	Corn.	Beans.	Peas.	Potatoes.	Turnips.
	grams.	grams.	grams.	grams.	grams.	grams.	grams.
Only soil phosphoric acid....	76.9	201.5	39.5	15.7	112.7	113.3	154.4
Water-insoluble phosphoric acid	148.6	294.9	108.3	17.4	196.7	114.6	304.1
Mostly water-soluble phosphoric acid.......	296.3	508.1	291.0	69.8	228.6	223.7	270.4

While it may not be desirable to draw definite conclusions from so small an amount of data as is furnished by the above described experiments, there are some points which under the conditions of these experiments the results appear to bring out sharply.

1st. Different crops showed a decided difference in their powers of obtaining phosphoric acid from crude, finely ground South Carolina rock. Wheat, barley, corn, peas and turnips apparently appropriated the insoluble phosphoric acid from this source with greater or less ease, while beans and potatoes derived no benefit from it.

2d. The greatest practical advantage derived from the use of find ground South Carolina rock was with the turnips. With this crop a larger weight of dry matter and also a larger weight of fresh roots was obtained with insoluble phosphoric acid from the finely ground South Carolina rock than with an equal amount of soluble phosphoric acid from acidulated South Carolina rock.

3d. The indications point to a profitable use of finely ground South Carolina rock as a manure for barley and peas, as well as turnips.

4th. The acidulated Soute Carolina rock in these experiments apparently depressed the yield of grain with barley, while largely increasing the amount of straw. With wheat, both grain and straw were largely increased and in about the same proportion.

MAINE STATE COLLEGE,
ORONO, ME., NOV. 1, 1894.

NOTE. These investigations are being continued and will be kept up, if possible, until the results warrant definite conclusions. Additional data are already obtained and experiments are now in progress. W. H. J.

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